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(54) **EXTENSIBLE BUTTRESS ASSEMBLY FOR SURGICAL STAPLER**

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A61L 31/06	(2006.01)
B29L 31/00	(2006.01)

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CPC .. ***A61B 17/07207*** (2013.01); ***A61B 17/00234*** (2013.01); ***A61B 17/07292*** (2013.01); ***A61L 31/06*** (2013.01); ***B29C 65/4805*** (2013.01); *A61B 2017/00526* (2013.01); *A61B 2017/00951* (2013.01); *A61B 2017/07257* (2013.01); *A61B 2017/07271* (2013.01); *A61B 2017/07278* (2013.01); *B29K 2995/0056* (2013.01); *B29L 2031/7546* (2013.01)

(58) **Field of Classification Search**

CPC A61B 2017/00526

USPC 227/176.1

See application file for complete search history.

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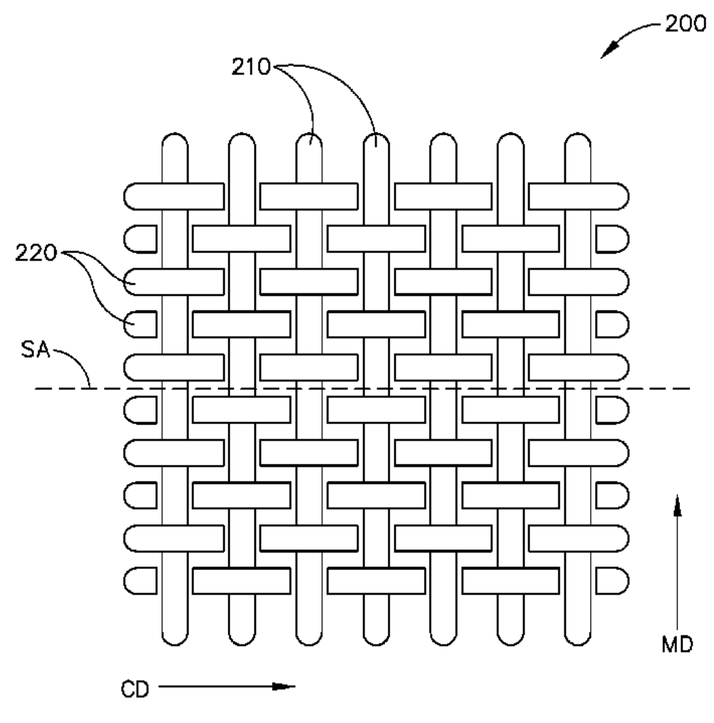
(57) **ABSTRACT**

A stretchable buttress assembly includes a planar fabric layer and a biocompatible adhesive layer. The planar fabric layer is configured to stretch along a stretch axis. The planar fabric layer includes extensible fibers and non-extensible fibers. The extensible fibers are arranged in a repeatable pattern. The extensible fibers are oriented along respective paths that are each parallel to the stretch axis. The non-extensible fibers are arranged in a repeatable pattern and engaged with the extensible fibers. The adhesive layer is applied to the planar fabric and is configured to removably adhere the planar fabric layer to an end effector of a surgical stapler.

9 Claims, 9 Drawing Sheets



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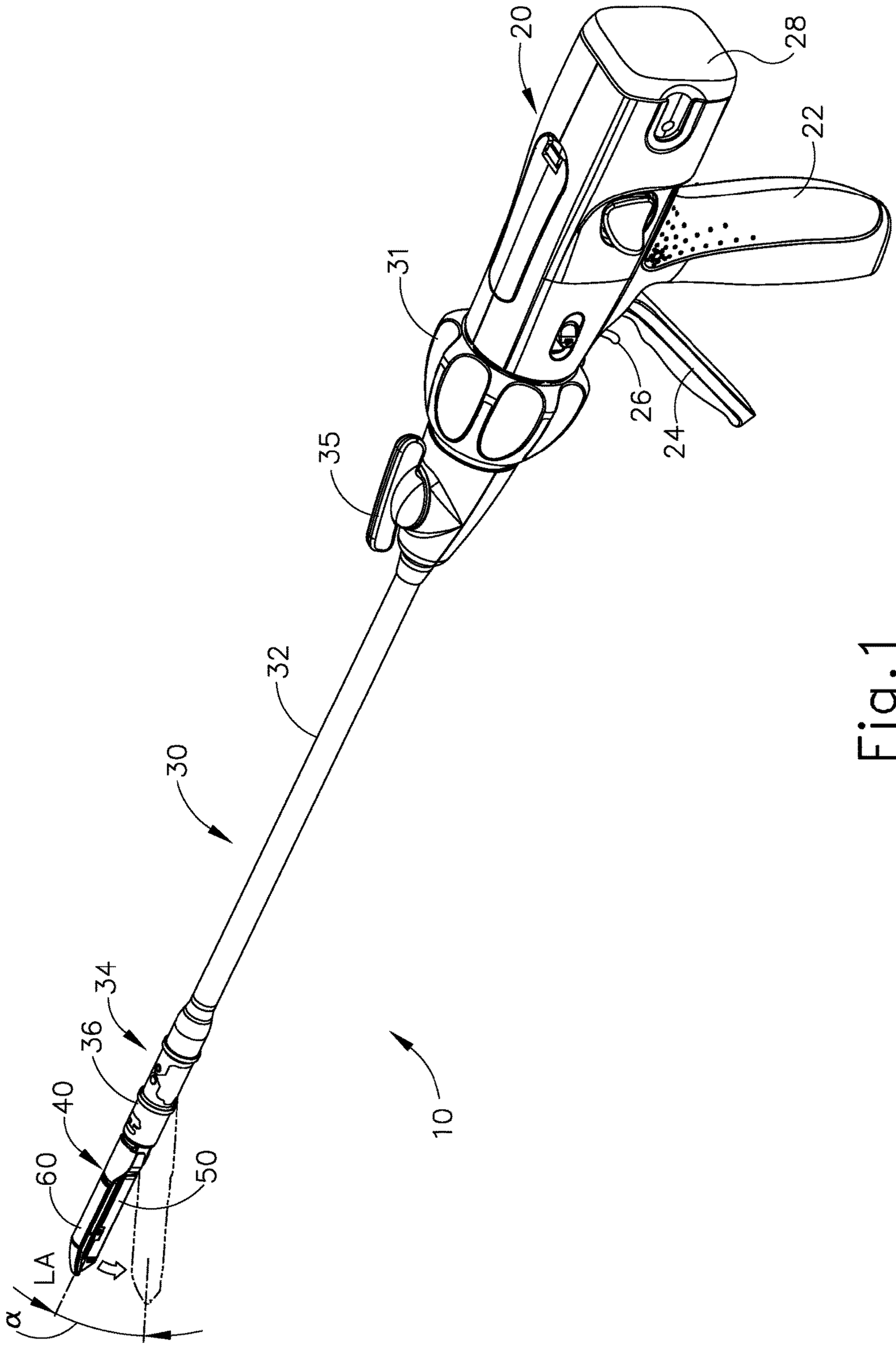

Fig. 1

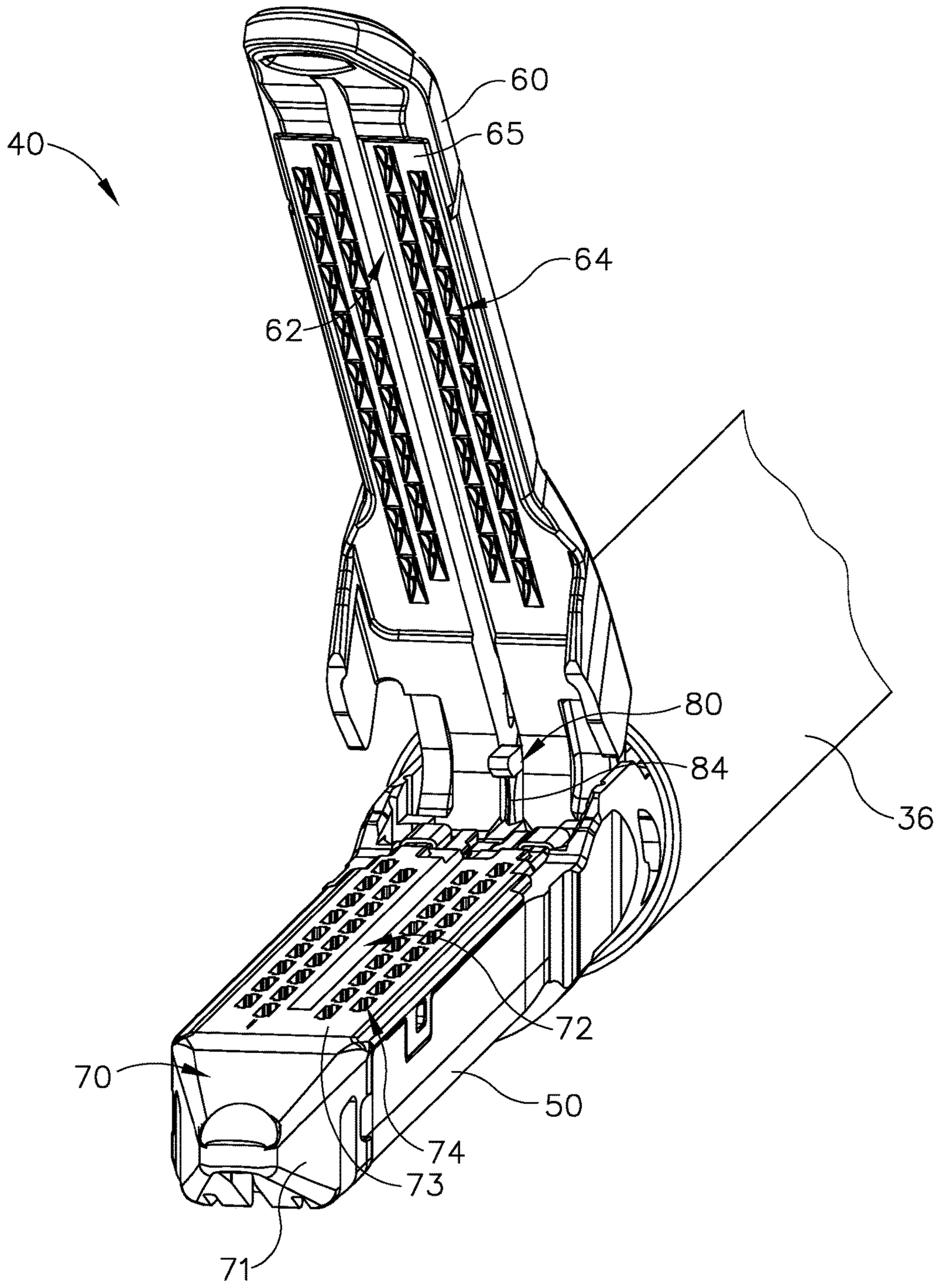

Fig.2

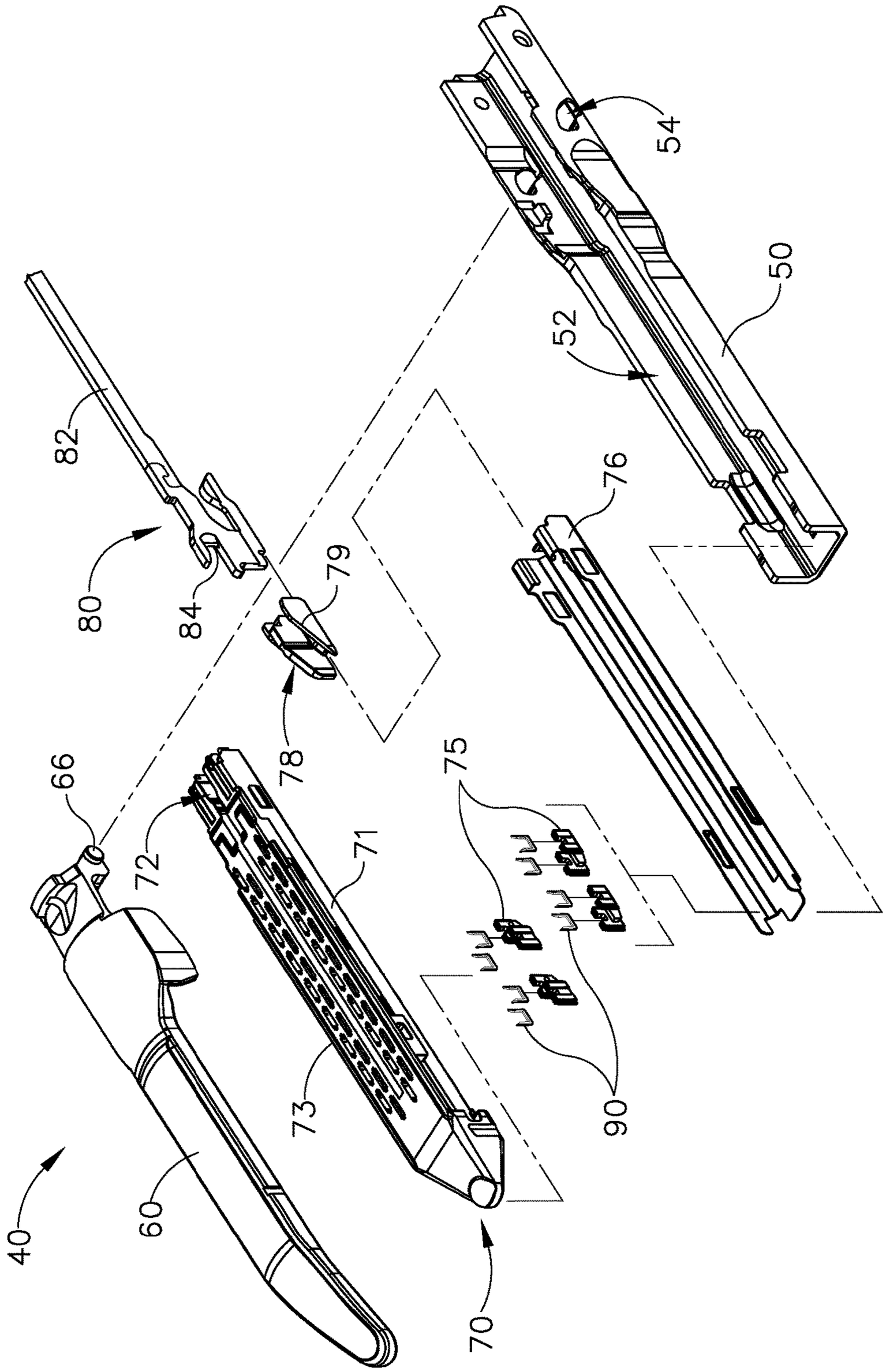

Fig.3

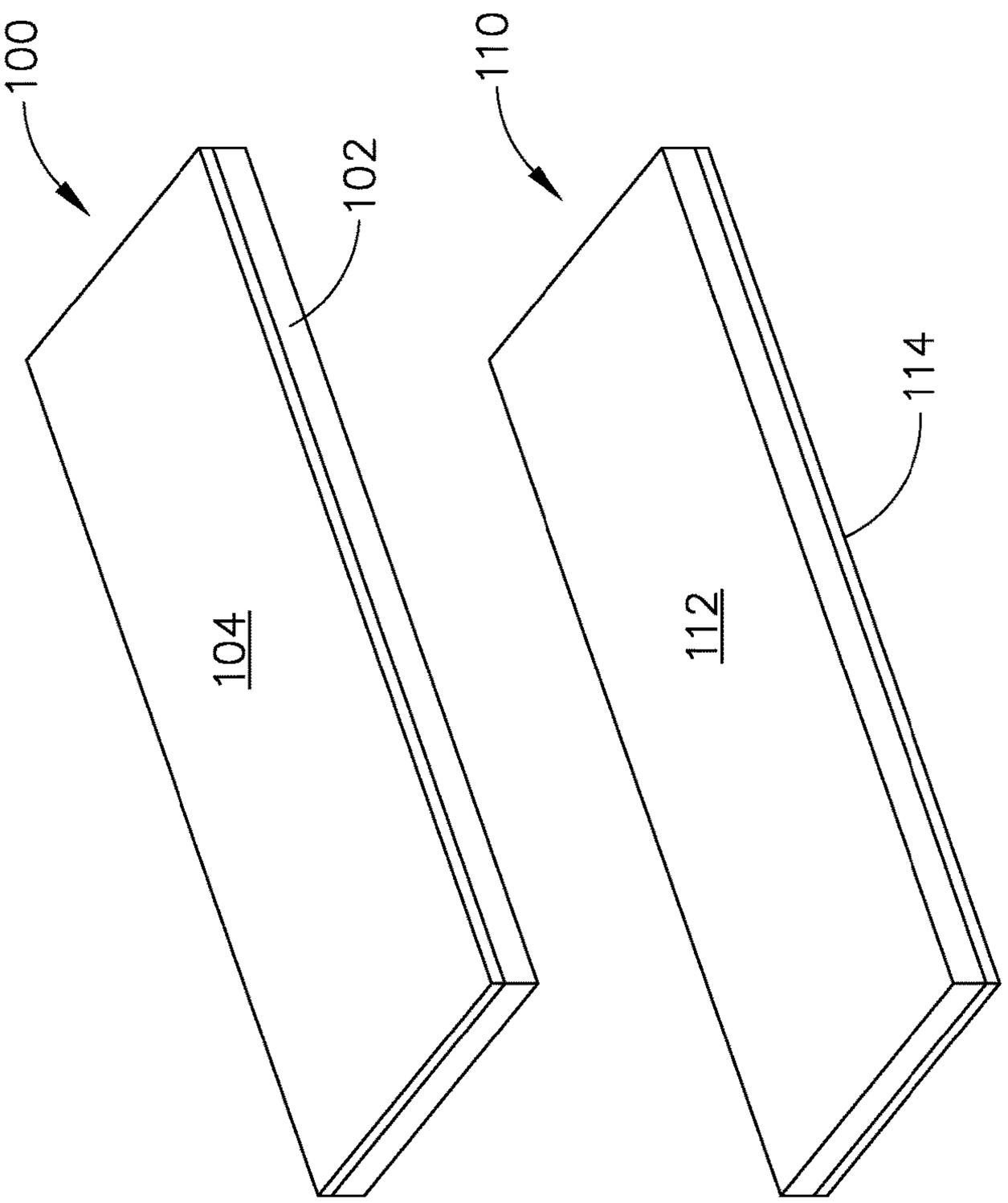

Fig. 4

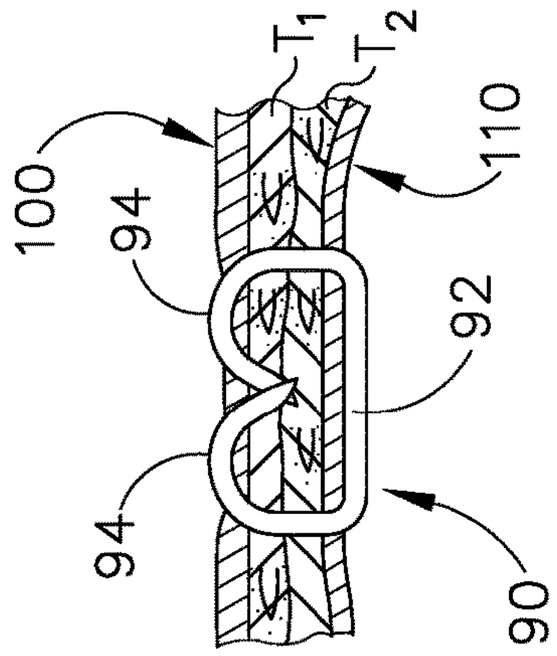

Fig.5C

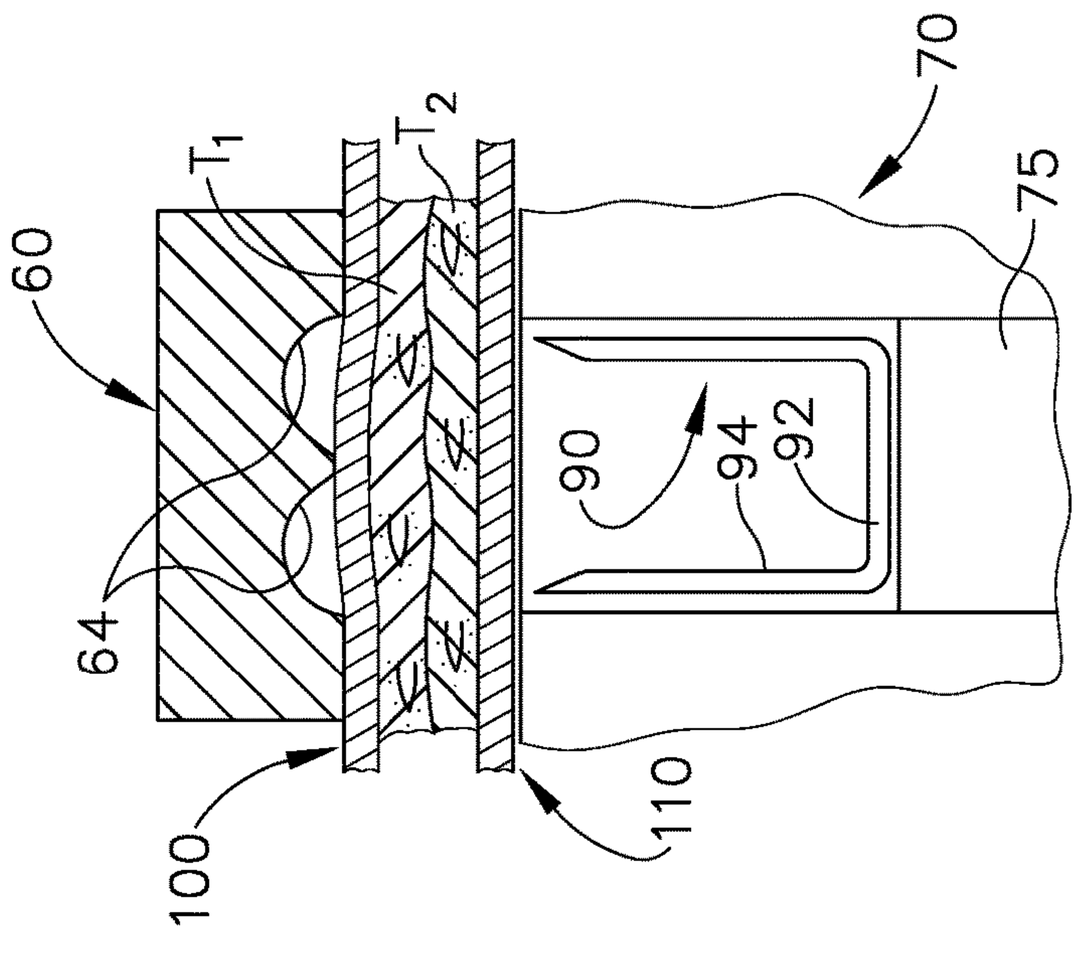

Fig.5B

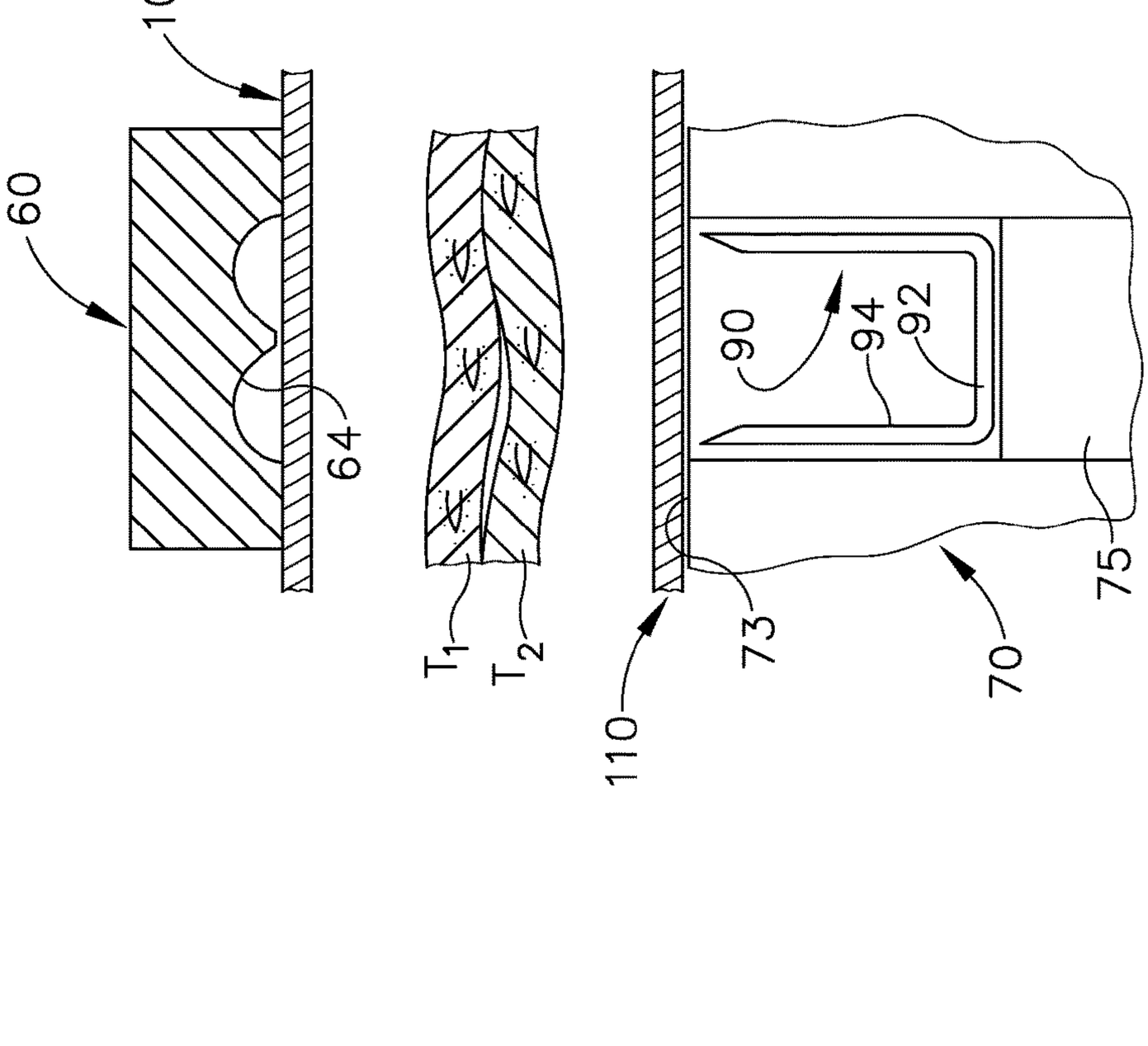

Fig.5A

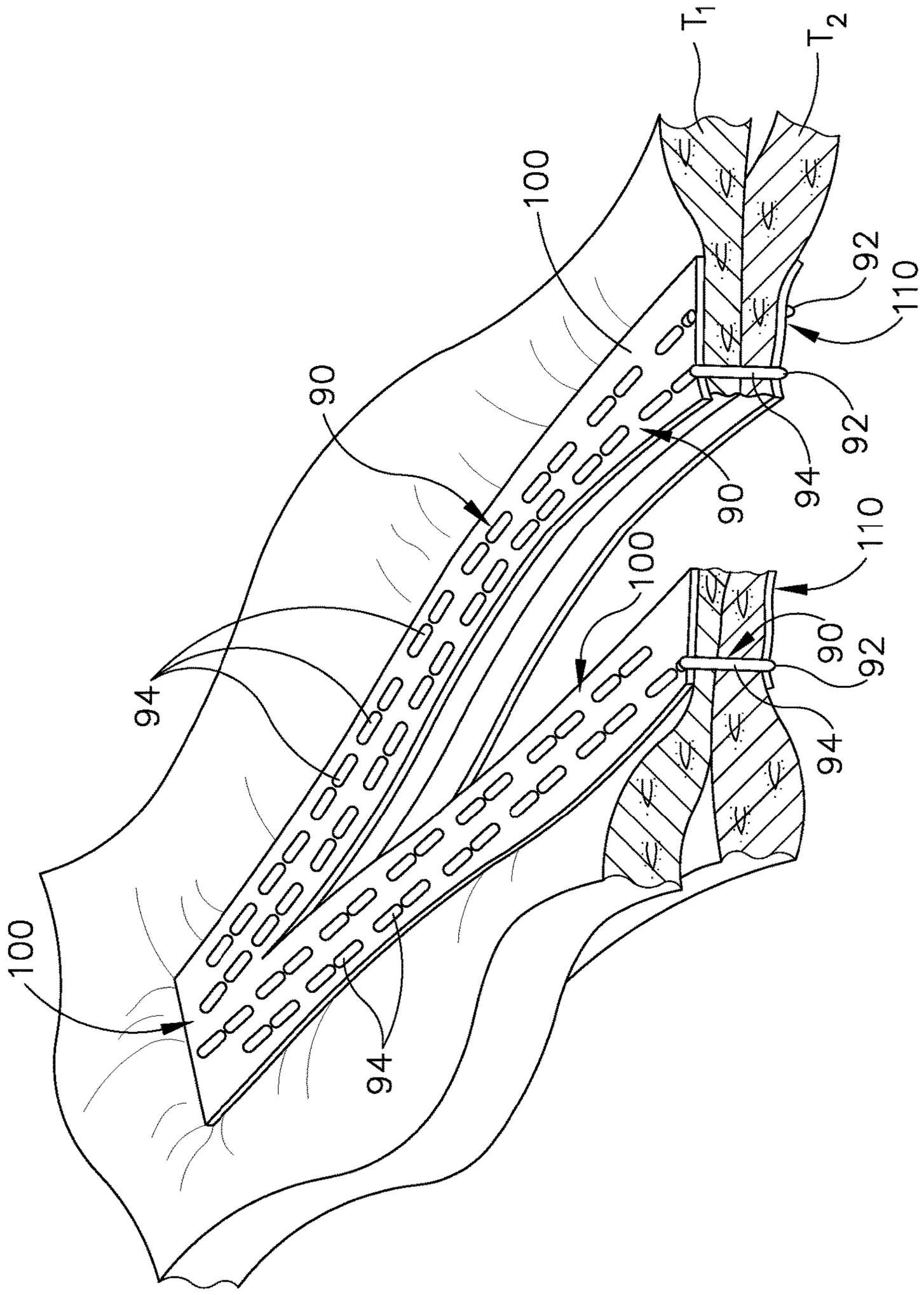

Fig.6

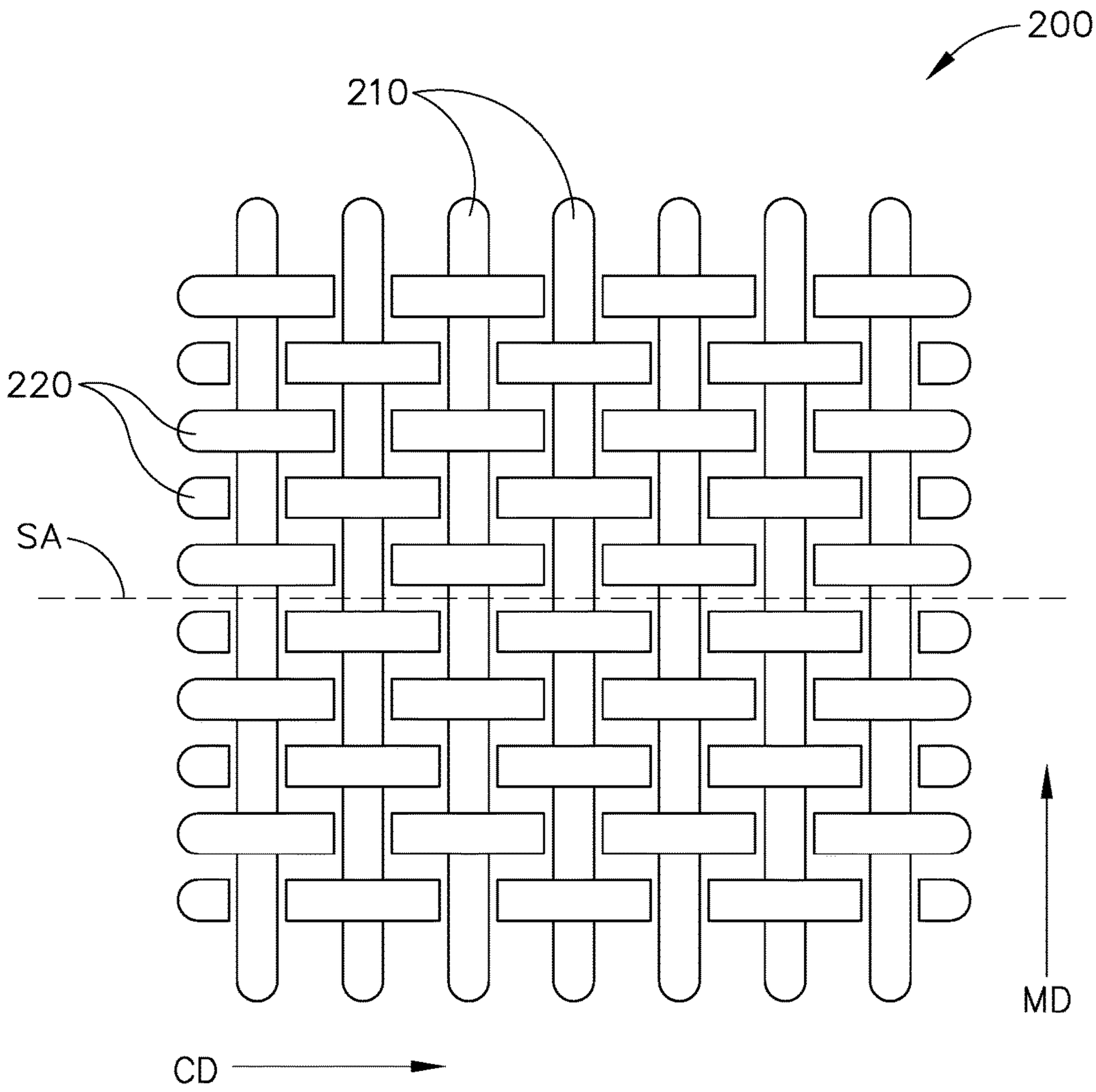

Fig.7

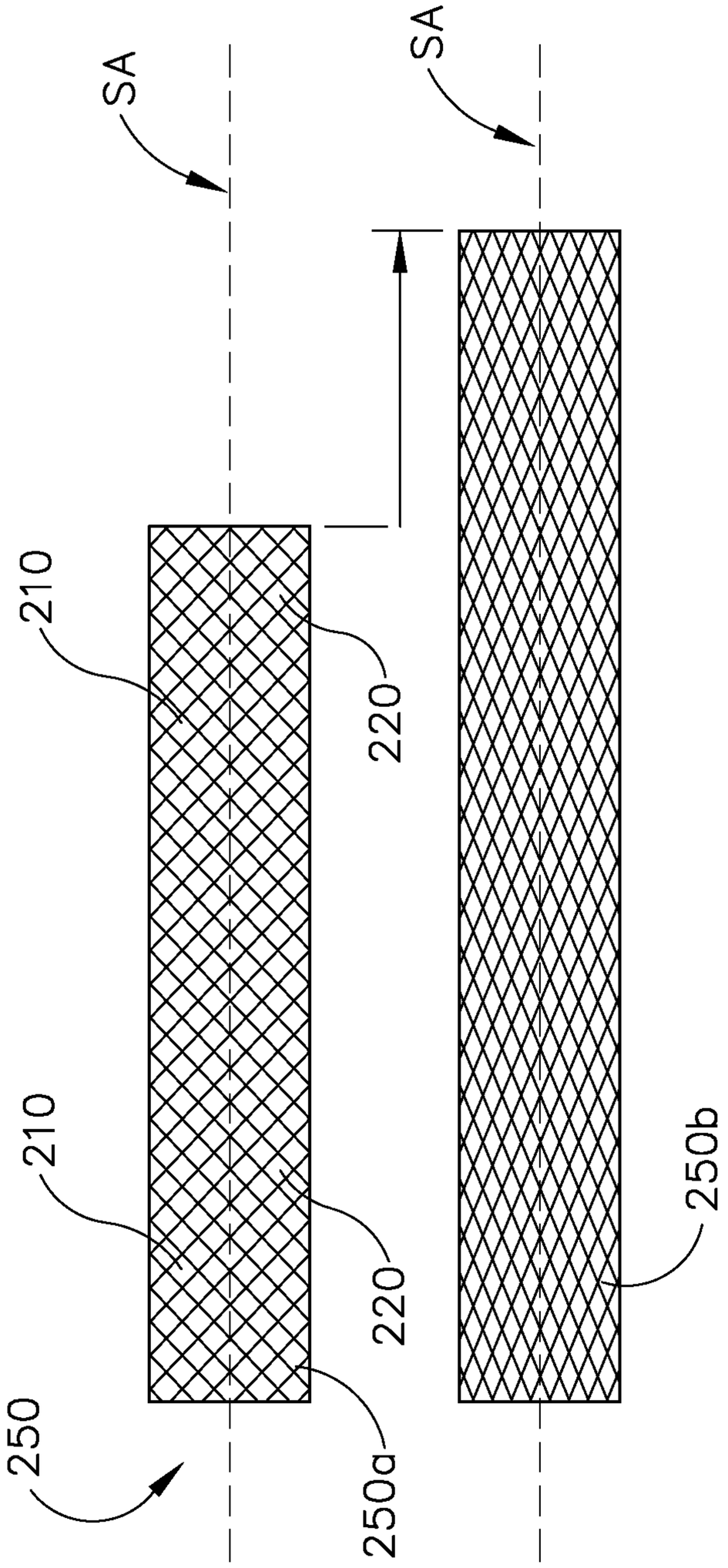

Fig.8

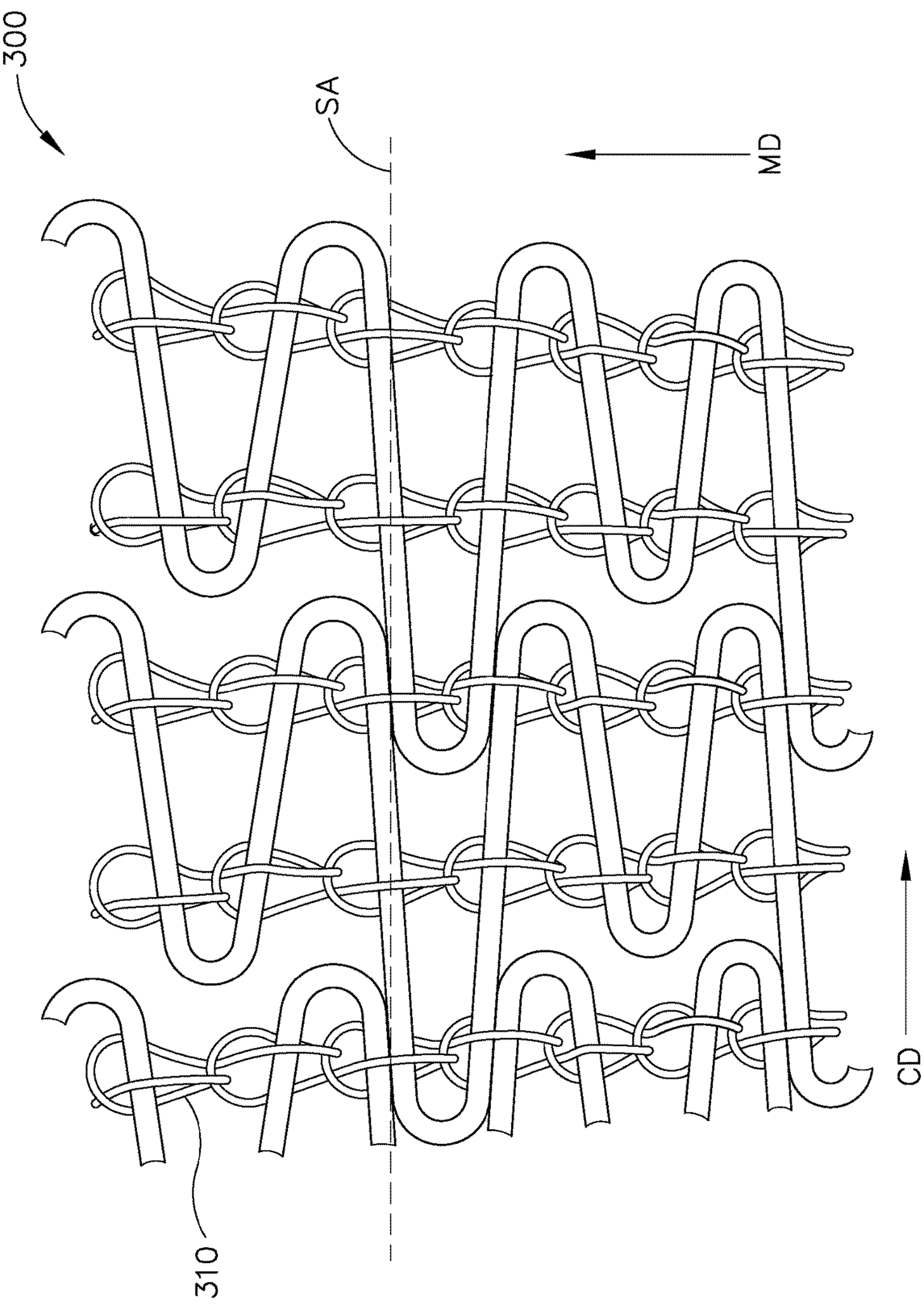

Fig.6

EXTENSIBLE BUTTRESS ASSEMBLY FOR SURGICAL STAPLER

BACKGROUND

In some settings, endoscopic surgical instruments may be preferred over traditional open surgical devices since a smaller incision may reduce the post-operative recovery time and complications. Consequently, some endoscopic surgical instruments may be suitable for placement of a distal end effector at a desired surgical site through the cannula of a trocar. These distal end effectors may engage tissue in a number of ways to achieve a diagnostic or therapeutic effect (e.g., endocutter, grasper, cutter, stapler, clip applier, access device, drug/gene therapy delivery device, and energy delivery device using ultrasonic vibration, RF, laser, etc.). Endoscopic surgical instruments may include a shaft between the end effector and a handle portion, which is manipulated by the clinician. Such a shaft may enable insertion to a desired depth and rotation about the longitudinal axis of the shaft, thereby facilitating positioning of the end effector within the patient. Positioning of an end effector may be further facilitated through inclusion of one or more articulation joints or features, enabling the end effector to be selectively articulated or otherwise deflected relative to the longitudinal axis of the shaft.

Examples of endoscopic surgical instruments include surgical staplers. Some such staplers are operable to clamp down on layers of tissue, cut through the clamped layers of tissue, and drive staples through the layers of tissue to substantially seal the severed layers of tissue together near the severed ends of the tissue layers. Merely exemplary surgical staplers are disclosed in U.S. Pat. No. 4,805,823, entitled "Pocket Configuration for Internal Organ Staplers," issued Feb. 21, 1989; U.S. Pat. No. 5,415,334, entitled "Surgical Stapler and Staple Cartridge," issued May 16, 1995; U.S. Pat. No. 5,465,895, entitled "Surgical Stapler Instrument," issued Nov. 14, 1995; U.S. Pat. No. 5,597,107, entitled "Surgical Stapler Instrument," issued Jan. 28, 1997; U.S. Pat. No. 5,632,432, entitled "Surgical Instrument," issued May 27, 1997; U.S. Pat. No. 5,673,840, entitled "Surgical Instrument," issued Oct. 7, 1997; U.S. Pat. No. 5,704,534, entitled "Articulation Assembly for Surgical Instruments," issued Jan. 6, 1998; U.S. Pat. No. 5,814,055, entitled "Surgical Clamping Mechanism," issued Sep. 29, 1998; U.S. Pat. No. 6,978,921, entitled "Surgical Stapling Instrument Incorporating an E-Beam Firing Mechanism," issued Dec. 27, 2005; U.S. Pat. No. 7,000,818, entitled "Surgical Stapling Instrument Having Separate Distinct Closing and Firing Systems," issued Feb. 21, 2006; U.S. Pat. No. 7,143,923, entitled "Surgical Stapling Instrument Having a Firing Lockout for an Unclosed Anvil," issued Dec. 5, 2006; U.S. Pat. No. 7,303,108, entitled "Surgical Stapling Instrument Incorporating a Multi-Stroke Firing Mechanism with a Flexible Rack," issued Dec. 4, 2007; U.S. Pat. No. 7,367,485, entitled "Surgical Stapling Instrument Incorporating a Multistroke Firing Mechanism Having a Rotary Transmission," issued May 6, 2008; U.S. Pat. No. 7,380,695, entitled "Surgical Stapling Instrument Having a Single Lockout Mechanism for Prevention of Firing," issued Jun. 3, 2008; U.S. Pat. No. 7,380,696, entitled "Articulating Surgical Stapling Instrument Incorporating a Two-Piece E-Beam Firing Mechanism," issued Jun. 3, 2008; U.S. Pat. No. 7,404,508, entitled "Surgical Stapling and Cutting Device," issued Jul. 29, 2008; U.S. Pat. No. 7,434,715, entitled "Surgical Stapling Instrument Having Multistroke Firing with Opening Lockout," issued Oct. 14, 2008; U.S. Pat. No. 7,721,930, entitled "Disposable Cartridge with Adhesive for Use with a Stapling Device," issued May 25, 2010; U.S. Pat. No. 8,408,439, entitled "Surgical Stapling Instrument with An Articulatable End Effector," issued Apr. 2, 2013; and U.S. Pat. No. 8,453,914, entitled "Motor-Driven Surgical Cutting Instrument with Electric Actuator Directional Control Assembly," issued Jun. 4, 2013. The disclosure of each of the above-cited U.S. patents is incorporated by reference herein.

While the surgical staplers referred to above are described as being used in endoscopic procedures, it should be understood that such surgical staplers may also be used in open procedures and/or other non-endoscopic procedures. By way of example only, a surgical stapler may be inserted through a thoracotomy, and thereby between a patient's ribs, to reach one or more organs in a thoracic surgical procedure that does not use a trocar as a conduit for the stapler. Such procedures may include the use of the stapler to sever and close a vessel leading to a lung. For instance, the vessels leading to an organ may be severed and closed by a stapler before removal of the organ from the thoracic cavity. Of course, surgical staplers may be used in various other settings and procedures.

Examples of surgical staplers that may be particularly suited for use through a thoracotomy are disclosed in U.S. Patent Pub. No. 2014/0243801, entitled "Surgical Instrument End Effector Articulation Drive with Pinion and Opposing Racks," published Aug. 28, 2014, issued as U.S. Pat. No. 9,186,142 on Nov. 17, 2015; U.S. Patent Pub. No. 2014/0239041, entitled "Lockout Feature for Movable Cutting Member of Surgical Instrument," published Aug. 28, 2014, issued as U.S. Pat. No. 9,717,497 on Aug. 1, 2017; U.S. Patent Pub. No. 2014/0239042, entitled "Integrated Tissue Positioning and Jaw Alignment Features for Surgical Stapler," published Aug. 28, 2014, issued as U.S. Pat. No. 9,517,065 on Dec. 13, 2016; U.S. Patent Pub. No. 2014/0239036, entitled "Jaw Closure Feature for End Effector of Surgical Instrument," published Aug. 28, 2014, issued as U.S. Pat. No. 9,839,421 on Dec. 12, 2017; U.S. Patent Pub. No. 2014/0239040, entitled "Surgical Instrument with Articulation Lock having a Detenting Binary Spring," published Aug. 28, 2014, issued as U.S. Pat. No. 9,867,615 on Jan. 16, 2018; U.S. Patent Pub. No. 2014/0239043, entitled "Distal Tip Features for End Effector of Surgical Instrument," published Aug. 28, 2014, issued as U.S. Pat. No. 9,622,746 on Apr. 18, 2017; U.S. Patent Pub. No. 2014/0239037, entitled "Staple Forming Features for Surgical Stapling Instrument," published Aug. 28, 2014, issued as U.S. Pat. No. 10,092,292 on Oct. 9, 2018; U.S. Patent Pub. No. 2014/0239038, entitled "Surgical Instrument with Multi-Diameter Shaft," published Aug. 28, 2014, issued as U.S. Pat. No. 9,795,379 on Oct. 24, 2017; and U.S. Patent Pub. No. 2014/0239044, entitled "Installation Features for Surgical Instrument End Effector Cartridge," published Aug. 28, 2014, issued as U.S. Pat. No. 9,808,248 on Nov. 7, 2017. The disclosure of each of the above-cited U.S. patent Publications is incorporated by reference herein.

Additional surgical stapling instruments are disclosed in U.S. Pat. No. 8,801,735, entitled "Surgical Circular Stapler with Tissue Retention Arrangements," issued Aug. 12, 2014; U.S. Pat. No. 8,141,762, entitled "Surgical Stapler Comprising a Staple Pocket," issued Mar. 27, 2012; U.S. Pat. No. 8,371,491, entitled "Surgical End Effector Having Buttress Retention Features," issued Feb. 12, 2013; U.S. Pub. No. 2014/0263563, entitled "Method and Apparatus for Sealing End-to-End Anastomosis" published Sep. 18, 2014, issued as U.S. Pat. No. 9,597,082 on Mar. 21, 2017; U.S. Pub. No.

2014/0246473, entitled "Rotary Powered Surgical Instruments with Multiple Degrees of Freedom," published Sep. 4, 2014, issued as U.S. Pat. No. 9,398,911 on Jul. 26, 2016; U.S. Pub. No. 2013/0206813, entitled "Linear Stapler," published Aug. 15, 2013, now abandoned; U.S. Pub. No. 2008/0169328, entitled "Buttress Material for Use with a Surgical Stapler," published Jul. 17, 2008, now abandoned; U.S. patent application Ser. No. 14/300,804, entitled "Woven and Fibrous Materials for Reinforcing a Staple Line," filed Jun. 10, 2014, issued as U.S. Pat. No. 9,878,871 on Dec. 26, 2017; U.S. patent application Ser. No. 14/300,811, entitled "Devices and Methods for Sealing Staples in Tissue", issued as U.S. Pat. No. 9,936,954 on Apr. 10, 2018; and U.S. patent application Ser. No. 14/498,070, entitled "Radically Expandable Staple Line" filed Sep. 26, 2014, published as U.S. Pub. No. 2016/0089146 on Mar. 21, 2016. The disclosure of each of the above-cited U.S. patents, U.S. patent Publications, and U.S. patent applications is incorporated by reference herein.

In some instances, it may be desirable to equip a surgical stapling instrument with a buttress material to reinforce the mechanical fastening of tissue provided by staples. Such a buttress may prevent the applied staples from pulling through tissue and may otherwise reduce a risk of tissue tearing at or near the site of applied staples.

While various kinds of surgical stapling instruments and associated components have been made and used, it is believed that no one prior to the inventor(s) has made or used the invention described in the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are incorporated in and constitute a part of this specification, illustrate embodiments of the invention, and, together with the general description of the invention given above, and the detailed description of the embodiments given below, serve to explain the principles of the present invention.

FIG. **1** depicts a perspective view of an exemplary articulating surgical stapling instrument;

FIG. **2** depicts a perspective view of an end effector of the instrument of FIG. **1**, with the end effector in an open configuration;

FIG. **3** depicts an exploded perspective view of the end effector of FIG. **2**;

FIG. **4** depicts a perspective view of an exemplary upper buttress and an exemplary lower buttress, each of which may be applied to the end effector of FIG. **2**;

FIG. **5**A depicts a cross-sectional end view of a portion of the end effector of FIG. **2** with a buttress assembly formed by the buttresses of FIG. **4** applied to the end effector, with tissue positioned between the buttresses in the end effector, and with the anvil in an open position;

FIG. **5**B depicts a cross-sectional end view of the combined end effector and buttress assembly of FIG. **5**A, with tissue positioned between the buttresses in the end effector, and with the anvil in a closed position;

FIG. **5**C depicts a cross-sectional view of a staple and the buttress assembly of FIG. **5**A having been secured to the tissue by the end effector of FIG. **2**;

FIG. **6** depicts a perspective view of staples and the buttress assembly of FIG. **5**A having been secured to the tissue by the end effector of FIG. **2**;

FIG. **7** depicts an enlarged schematic view of an exemplary planar fabric comprising woven fibers, suitable for incorporation into the buttresses of FIG. **4**;

FIG. **8** depicts two top plan views showing a buttress body in a stretched state and the buttress body in a relaxed state; and

FIG. **9** depicts an enlarged schematic view of an exemplary planar fabric comprising knitted fibers, suitable for incorporation into the buttresses of FIG. **4**.

The drawings are not intended to be limiting in any way, and it is contemplated that various embodiments of the invention may be carried out in a variety of other ways, including those not necessarily depicted in the drawings. The accompanying drawings incorporated in and forming a part of the specification illustrate several aspects of the present invention, and together with the description serve to explain the principles of the invention; it being understood, however, that this invention is not limited to the precise arrangements shown.

DETAILED DESCRIPTION

The following description of certain examples of the invention should not be used to limit the scope of the present invention. Other examples, features, aspects, embodiments, and advantages of the invention will become apparent to those skilled in the art from the following description, which is by way of illustration, one of the best modes contemplated for carrying out the invention. As will be realized, the invention is capable of other different and obvious aspects, all without departing from the invention. Accordingly, the drawings and descriptions should be regarded as illustrative in nature and not restrictive.

I. Exemplary Surgical Stapler

FIG. **1** depicts an exemplary surgical stapling and severing instrument (**10**) that includes a handle assembly (**20**), a shaft assembly (**30**), and an end effector (**40**). End effector (**40**) and the distal portion of shaft assembly (**30**) are sized for insertion, in a nonarticulated state as depicted in FIG. **1**, through a trocar cannula to a surgical site in a patient for performing a surgical procedure. By way of example only, such a trocar may be inserted in a patient's abdomen, between two of the patient's ribs, or elsewhere. In some settings, instrument (**10**) is used without a trocar. For instance, end effector (**40**) and the distal portion of shaft assembly (**30**) may be inserted directly through a thoracotomy or other type of incision. It should be understood that terms such as "proximal" and "distal" are used herein with reference to a clinician gripping handle assembly (**20**) of instrument (**10**). Thus, end effector (**40**) is distal with respect to the more proximal handle assembly (**20**). It will be further appreciated that for convenience and clarity, spatial terms such as "vertical" and "horizontal" are used herein with respect to the drawings. However, surgical instruments are used in many orientations and positions, and these terms are not intended to be limiting and absolute.

A. Exemplary Handle Assembly and Shaft Assembly

As shown in FIG. **1**, handle assembly (**20**) of the present example comprises pistol grip (**22**), a closure trigger (**24**), and a firing trigger (**26**). Each trigger (**24**, **26**) is selectively pivotable toward and away from pistol grip (**22**) as will be described in greater detail below. Handle assembly (**20**) further includes a removable battery pack (**28**). These components will also be described in greater detail below. Of course, handle assembly (**20**) may have a variety of other components, features, and operabilities, in addition to or in lieu of any of those noted above. Other suitable configura-

tions for handle assembly (**20**) will be apparent to those of ordinary skill in the art in view of the teachings herein.

As shown in FIGS. **1-2**, shaft assembly (**30**) of the present example comprises an outer closure tube (**32**), an articulation section (**34**), and a closure ring (**36**), which is further coupled with end effector (**40**). Closure tube (**32**) extends along the length of shaft assembly (**30**). Closure ring (**36**) is positioned distal to articulation section (**34**). Closure tube (**32**) and closure ring (**36**) are configured to translate longitudinally relative to handle assembly (**20**). Longitudinal translation of closure tube (**32**) is communicated to closure ring (**36**) via articulation section (**34**). Exemplary features that may be used to provide longitudinal translation of closure tube (**32**) and closure ring (**36**) will be described in greater detail below.

Articulation section (**34**) is operable to laterally deflect closure ring (**36**) and end effector (**40**) laterally away from the longitudinal axis (LA) of shaft assembly (**30**) at a desired angle (a). In the present example, articulation is controlled through an articulation control knob (**35**) which is located at the proximal end of shaft assembly (**30**). Closure ring (**36**) and end effector (**40**) pivot about an axis that is perpendicular to the longitudinal axis (LA) of shaft assembly (**30**) in response to rotation of knob (**35**). Articulation section (**34**) is configured to communicate longitudinal translation of closure tube (**32**) to closure ring (**36**), regardless of whether articulation section (**34**) is in a straight configuration or an articulated configuration. By way of example only, articulation section (**34**) and/or articulation control knob (**35**) may be constructed and operable in accordance with at least some of the teachings of U.S. Pub. No. 2014/0243801, entitled "Surgical Instrument End Effector Articulation Drive with Pinion and Opposing Racks," published Aug. 28, 2014, issued as U.S. Pat. No. 9,186,142 on Nov. 7, 2015, the disclosure of which is incorporated by reference herein; and/or U.S. patent application Ser. No. 14/314,125, entitled "Articulation Drive Features for Surgical Stapler," filed Jun. 25, 2014, published as U.S. Pub. No. 2015/0374360 on Dec. 31, 2015, the disclosure of which is incorporated by reference herein; and/or in accordance with the various teachings below. Other suitable forms that articulation section (**34**) and articulation knob (**35**) may take will be apparent to those of ordinary skill in the art in view of the teachings herein.

As shown in FIG. **1**, shaft assembly (**30**) of the present example further includes a rotation knob (**31**). Rotation knob (**31**) is operable to rotate the entire shaft assembly (**30**) and end effector (**40**) relative to handle assembly (**20**) about the longitudinal axis (LA) of shaft assembly (**30**). Of course, shaft assembly (**30**) may have a variety of other components, features, and operabilities, in addition to or in lieu of any of those noted above. By way of example only, at least part of shaft assembly (**30**) is constructed in accordance with at least some of the teachings of U.S. Pub. No. 2014/0239038, entitled "Surgical Instrument with Multi-Diameter Shaft," published Aug. 28, 2014, issued as U.S. Pat. No. 9,795,379 on Oct. 24, 2017, the disclosure of which is incorporated by reference herein. Other suitable configurations for shaft assembly (**30**) will be apparent to those of ordinary skill in the art in view of the teachings herein.

B. Exemplary End Effector

As also shown in FIGS. **1-3**, end effector (**40**) of the present example includes a lower jaw (**50**) and a pivotable anvil (**60**). Anvil (**60**) includes a pair of integral, outwardly extending pins (**66**) that are disposed in corresponding curved slots (**54**) of lower jaw (**50**). Anvil (**60**) is pivotable toward and away from lower jaw (**50**) between an open position (shown in FIG. **2**) and a closed position (shown in FIG. **1**). Use of the term "pivotable" (and similar terms with "pivot" as a base) should not be read as necessarily requiring pivotal movement about a fixed axis. For instance, in the present example, anvil (**60**) pivots about an axis that is defined by pins (**66**), which slide along curved slots (**54**) of lower jaw (**50**) as anvil (**60**) moves toward lower jaw (**50**). In such versions, the pivot axis translates along the path defined by slots (**54**) while anvil (**60**) simultaneously pivots about that axis. In addition or in the alternative, the pivot axis may slide along slots (**54**) first, with anvil (**60**) then pivoting about the pivot axis after the pivot axis has slid a certain distance along the slots (**54**). It should be understood that such sliding/translating pivotal movement is encompassed within terms such as "pivot," "pivots," "pivotal," "pivotable," "pivoting," and the like. Of course, some versions may provide pivotal movement of anvil (**60**) about an axis that remains fixed and does not translate within a slot or channel, etc.

As best seen in FIG. **3**, lower jaw (**50**) of the present example defines a channel (**52**) that is configured to receive a staple cartridge (**70**). Staple cartridge (**70**) may be inserted into channel (**52**), end effector (**40**) may be actuated, and then staple cartridge (**70**) may be removed and replaced with another staple cartridge (**70**). Lower jaw (**50**) thus releasably retains staple cartridge (**70**) in alignment with anvil (**60**) for actuation of end effector (**40**). In some versions, lower jaw (**50**) is constructed in accordance with at least some of the teachings of U.S. Pub. No. 2014/0239044, entitled "Installation Features for Surgical Instrument End Effector Cartridge," published Aug. 28, 2014, issued as U.S. Pat. No. 9,808,248 on Nov. 7, 2017, the disclosure of which is incorporated by reference herein. Other suitable forms that lower jaw (**50**) may take will be apparent to those of ordinary skill in the art in view of the teachings herein.

As best seen in FIGS. **2-3**, staple cartridge (**70**) of the present example comprises a cartridge body (**71**) and a tray (**76**) secured to the underside of cartridge body (**71**). The upper side of cartridge body (**71**) presents a deck (**73**), against which tissue may be compressed when anvil (**60**) is in a closed position. Cartridge body (**71**) further defines a longitudinally extending channel (**72**) and a plurality of staple pockets (**74**). A staple (**90**) is positioned in each staple pocket (**74**). A staple driver (**75**) is also positioned in each staple pocket (**74**), underneath a corresponding staple (**90**), and above tray (**76**). As will be described in greater detail below, staple drivers (**75**) are operable to translate upwardly in staple pockets (**74**) to thereby drive staples (**90**) upwardly through staple pockets (**74**) and into engagement with anvil (**60**). Staple drivers (**75**) are driven upwardly by a wedge sled (**78**), which is captured between cartridge body (**71**) and tray (**76**), and which translates longitudinally through cartridge body (**71**).

Wedge sled (**78**) includes a pair of obliquely angled cam surfaces (**79**), which are configured to engage staple drivers (**75**) and thereby drive staple drivers (**75**) upwardly as wedge sled (**78**) translates longitudinally through cartridge (**70**). For instance, when wedge sled (**78**) is in a proximal position, staple drivers (**75**) are in downward positions and staples (**90**) are located in staple pockets (**74**). As wedge sled (**78**) is driven to the distal position by a translating knife member (**80**), wedge sled (**78**) drives staple drivers (**75**) upwardly, thereby driving staples (**90**) out of staple pockets (**74**) and into staple forming pockets (**64**) that are formed in the underside (**65**) of anvil (**60**). Thus, staple drivers (**75**) translate along a vertical dimension as wedge sled (**78**) translates along a horizontal dimension.

In some versions, staple cartridge (**70**) is constructed and operable in accordance with at least some of the teachings of U. U.S. Pub. No. 2014/0239042, entitled "Integrated Tissue Positioning and Jaw Alignment Features for Surgical Stapler," published Aug. 28, 2014, issued as U.S. Pat. No. 9,517,065 on Dec. 13, 2016, the disclosure of which is incorporated by reference herein. In addition or in the alternative, staple cartridge (**70**) may be constructed and operable in accordance with at least some of the teachings of U.S. Pub. No. 2014/0239044, entitled "Installation Features for Surgical Instrument End Effector Cartridge," published Aug. 28, 2014,issued as U.S. Pat. No. 9,808,248 on Nov. 7, 2017, the disclosure of which is incorporated by reference herein. Other suitable forms that staple cartridge (**70**) may take will be apparent to those of ordinary skill in the art in view of the teachings herein.

As best seen in FIG. **2**, anvil (**60**) of the present example comprises a longitudinally extending channel (**62**) and a plurality of staple forming pockets (**64**). Channel (**62**) is configured to align with channel (**72**) of staple cartridge (**70**) when anvil (**60**) is in a closed position. Each staple forming pocket (**64**) is positioned to lie over a corresponding staple pocket (**74**) of staple cartridge (**70**) when anvil (**60**) is in a closed position. Staple forming pockets (**64**) are configured to deform the legs of staples (**90**) when staples (**90**) are driven through tissue and into anvil (**60**). In particular, staple forming pockets (**64**) are configured to bend the legs of staples (**90**) to secure the formed staples (**90**) in the tissue. Anvil (**60**) may be constructed in accordance with at least some of the teachings of U.S. Pub. No. 2014/0239042, entitled "Integrated Tissue Positioning and Jaw Alignment Features for Surgical Stapler," published Aug. 28, 2014, issued as U.S. Pat. No. 9,517,065 on Dec. 13, 2016; at least some of the teachings of U.S. Pub. No. 2014/0239036, entitled "Jaw Closure Feature for End Effector of Surgical Instrument," published Aug. 28, 2014, issued as U.S. Pat. No. 9,839,421 on Dec. 12, 2017; and/or at least some of the teachings of U.S. Pub. No. 2014/0239037, entitled "Staple Forming Features for Surgical Stapling Instrument," published Aug. 28, 2014, issued as U.S. Pat. No. 10,092,292 on Oct. 9, 2018, the disclosure of which is incorporated by reference herein. Other suitable forms that anvil (**60**) may take will be apparent to those of ordinary skill in the art in view of the teachings herein.

In the present example, a knife member (**80**) is configured to translate through end effector (**40**). As best seen in FIG. **3**, knife member (**80**) is secured to the distal end of a firing beam (**82**), which extends through a portion of shaft assembly (**30**). As best seen in FIG. **2**, knife member (**80**) is positioned in channels (**62**, **72**) of anvil (**60**) and staple cartridge (**70**). Knife member (**80**) includes a distally presented cutting edge (**84**) that is configured to sever tissue that is compressed between anvil (**60**) and deck (**73**) of staple cartridge (**70**) as knife member (**80**) translates distally through end effector (**40**). As noted above, knife member (**80**) also drives wedge sled (**78**) distally as knife member (**80**) translates distally through end effector (**40**), thereby driving staples (**90**) through tissue and against anvil (**60**) into formation.

C. Exemplary Actuation of End Effector

In the present example, anvil (**60**) is driven toward lower jaw (**50**) by advancing closure ring (**36**) distally relative to end effector (**40**). Closure ring (**36**) cooperates with anvil (**60**) through a camming action to drive anvil (**60**) toward lower jaw (**50**) in response to distal translation of closure ring (**36**) relative to end effector (**40**). Similarly, closure ring (**36**) may cooperate with anvil (**60**) to open anvil (**60**) away from lower jaw (**50**) in response to proximal translation of closure ring (**36**) relative to end effector (**40**). By way of example only, closure ring (**36**) and anvil (**60**) may interact in accordance with at least some of the teachings of U.S. Pub. No. 2014/0239036, entitled "Jaw Closure Feature for End Effector of Surgical Instrument," published Aug. 28, 2014, issued as U.S. Pat. No. 9,839,421 on Dec. 12, 2017, the disclosure of which is incorporated by reference herein; and/or in accordance with at least some of the teachings of U.S. patent application Ser. No. 14/314,108, entitled "Jaw Opening Feature for Surgical Stapler," filed on Jun. 25, 2014, published as U.S. Pub. No. 2015/0374373 on Dec. 31, 2015, the disclosure of which is incorporated by reference herein.

As noted above, handle assembly (**20**) includes a pistol grip (**22**) and a closure trigger (**24**). As also noted above, anvil (**60**) is closed toward lower jaw (**50**) in response to distal advancement of closure ring (**36**). In the present example, closure trigger (**24**) is pivotable toward pistol grip (**22**) to drive closure tube (**32**) and closure ring (**36**) distally. Various suitable components that may be used to convert pivotal movement of closure trigger (**24**) toward pistol grip (**22**) into distal translation of closure tube (**32**) and closure ring (**36**) relative to handle assembly (**20**) will be apparent to those of ordinary skill in the art in view of the teachings herein.

Also in the present example, instrument (**10**) provides motorized control of firing beam (**82**). In particular, instrument (**10**) includes motorized components that are configured to drive firing beam (**82**) distally in response to pivoting of firing trigger (**26**) toward pistol grip (**22**). In some versions, a motor (not shown) is contained in pistol grip (**22**) and receives power from battery pack (**28**). This motor is coupled with a transmission assembly (not shown) that converts rotary motion of a drive shaft of the motor into linear translation of firing beam (**82**). By way of example only, the features that are operable to provide motorized actuation of firing beam (**82**) may be configured and operable in accordance with at least some of the teachings of U.S. Pat. No. 8,210,411, entitled "Motor-Driven Surgical Instrument," issued Jul. 3, 2012, the disclosure of which is incorporated by reference herein; U.S. Pat. No. 8,453,914, entitled "Motor-Driven Surgical Cutting Instrument with Electric Actuator Directional Control Assembly," issued Jun. 4, 2013, the disclosure of which is incorporated by reference herein; and/or U.S. patent application Ser. No. 14/226,142, entitled "Surgical Instrument Comprising a Sensor System," filed Mar. 26, 2014, issued as U.S. Pat. No. 9,913,642 on Mar. 13, 2018, the disclosure of which is incorporated by reference herein.

It should also be understood that any other components or features of instrument (**10**) may be configured and operable in accordance with any of the various references cited herein. Additional exemplary modifications that may be provided for instrument (**10**) will be described in greater detail below. Various suitable ways in which the below teachings may be incorporated into instrument (**10**) will be apparent to those of ordinary skill in the art. Similarly, various suitable ways in which the below teachings may be combined with various teachings of the references cited herein will be apparent to those of ordinary skill in the art. It should therefore be understood that the teachings below may be readily incorporated into the various instruments taught in the various references that are cited herein. It should also be understood that the below teachings are not limited to instrument (**10**) or devices taught in the references cited herein. The below teachings may be readily applied to

various other kinds of instruments, including instruments that would not be classified as surgical staplers. Various other suitable devices and settings in which the below teachings may be applied will be apparent to those of ordinary skill in the art in view of the teachings herein.

II. Exemplary Buttress Assembly for Surgical Stapler

In some instances, it may be desirable to equip end effector (**40**) with a buttress material to reinforce the mechanical fastening of tissue provided by staples (**90**). Such a buttress may prevent the applied staples (**90**) from pulling through the tissue and may otherwise reduce a risk of tissue tearing at or near the site of applied staples (**90**). In addition to or as an alternative to providing structural support and integrity to a line of staples (**90**), a buttress may provide various other kinds of effects such as spacing or gap-filling, administration of therapeutic agents, and/or other effects. In some instances, a buttress may be provided on deck (**73**) of staple cartridge (**70**). In some other instances, a buttress may be provided on the surface of anvil (**60**) that faces staple cartridge (**70**). It should also be understood that a first buttress may be provided on deck (**73**) of staple cartridge (**70**) while a second buttress is provided on anvil (**60**) of the same end effector (**40**). Various examples of forms that a buttress may take will be described in greater detail below. Various ways in which a buttress may be secured to a staple cartridge (**70**) or an anvil (**60**) will also be described in greater detail below.

A. Exemplary Composition of Buttress Assembly for Surgical Stapler

FIG. **4** shows an exemplary pair of buttress assemblies (**100**, **110**) with a basic composition. Buttress assembly (**100**) of this example comprises a buttress body (**102**) and an upper adhesive layer (**104**). Similarly, buttress assembly (**110**) comprises a buttress body (**112**) and a lower adhesive layer (**114**). In the present example, each buttress body (**102**, **112**) comprises a strong yet flexible material configured to structurally support a line of staples (**90**). By way of example only, each buttress body (**102**, **112**) may comprise a woven mesh of polyglactin 910 material by Ethicon, Inc. of Somerville, N.J. Alternatively, any other suitable materials or combinations of materials may be used in addition to or as an alternative to polyglactin 910 material to form each buttress body (**102**, **112**). Each buttress body (**102**, **112**) may take any other suitable form and may be constructed of any other suitable material(s). By way of further example only, each buttress body (**102**, **112**) may comprise one or more of the following: NEOVEIL absorbable PGA felt by Gunze Limited, of Kyoto, Japan; SEAMGUARD polyglycolic acid:trimethylene carbonate (PGA:TMC) reinforcement material by W.L. Gore & Associates, Inc., of Flagstaff, Ariz.; PERI-STRIPS DRY with VERITAS Collagen Matrix (PSDV) reinforcement material, by Baxter Healthcare Corporation of Deerfield, Ill.; BIODESIGN biologic graft material by Cook Medical, Bloomington, Ind.; and/or SURGICEL NU-KNIT hemostat material by Ethicon, Inc. of Somerville, N.J. Still other suitable materials that may be used to form each buttress body (**102**, **112**) will be apparent to those of ordinary skill in the art in view of the teachings herein.

In addition or in the alternative, each buttress body (**102**, **112**) may comprise a material including, for example, a hemostatic agent such as fibrin to assist in coagulating blood and reduce bleeding at the severed and/or stapled surgical site along tissue (**90**). As another merely illustrative example, each buttress body (**102**, **112**) may comprise other adjuncts or hemostatic agents such as thrombin may be used such that each buttress body (**102**, **112**) may assist to coagulate blood and reduce the amount of bleeding at the surgical site. Other adjuncts or reagents that may be incorporated into each buttress body (**102**, **112**) may further include but are not limited to medical fluid or matrix components. Merely illustrative examples of materials that may be used to form each buttress body (**102**, **112**), as well as materials that may be otherwise incorporated into each buttress body (**102**, **112**), are disclosed in U.S. patent application Ser. No. 14/667,842, entitled "Method of Applying a Buttress to a Surgical Stapler," filed Mar. 25, 2015, published as U.S. Pub. No. 2016/0278774 on Sep. 29, 2016, the disclosure of which is incorporated by reference herein. Alternatively, any other suitable materials may be used.

By way of further example only, each buttress body (**102**, **112**) may be constructed in accordance with at least some of the teachings of U.S. Patent Pub. No. 2012/0241493, entitled "Tissue Thickness Compensator Comprising Controlled Release and Expansion," published Sep. 27, 2012, issued as U.S. Pat. No. 10,123,798 on Nov. 13, 2018, the disclosure of which is incorporated by reference herein; U.S. Patent Pub. No. 2013/0068816, entitled "Surgical Instrument and Buttress Material," published Mar. 21, 2013, now abandoned, the disclosure of which is incorporated by reference herein; U.S. Patent Pub. No. 2013/0062391, entitled "Surgical Instrument with Fluid Fillable Buttress," published Mar. 14, 2013, issued as U.S. Pat. No. 9,999,408 on Jun. 19, 2018, the disclosure of which is incorporated by reference herein; U.S. Patent Pub. No. 2013/0068820, entitled "Fibrin Pad Matrix with Suspended Heat Activated Beads of Adhesive," published Mar. 21, 2013, issued as U.S. Pat. No. 8,814,025 on Aug. 26, 2014, the disclosure of which is incorporated by reference herein; U.S. Patent Pub. No. 2013/0082086, entitled "Attachment of Surgical Staple Buttress to Cartridge," published Apr. 4, 2013, issued as U.S. Pat. No. 8,899,464 on Dec. 2, 2014, the disclosure of which is incorporated by reference herein; U.S. Patent Pub. No. 2013/0037596, entitled "Device for Applying Adjunct in Endoscopic Procedure," published Feb. 14, 2013, issued as U.S. Pat. No. 9,492,170 on Nov. 15, 2016, the disclosure of which is incorporated by reference herein; U.S. Patent Pub. No. 2013/0062393, entitled "Resistive Heated Surgical Staple Cartridge with Phase Change Sealant," published Mar. 14, 2013, issued as U.S. Pat. No. 8,998,060 on Apr. 7, 2015, the disclosure of which is incorporated by reference herein; U.S. Patent Pub. No. 2013/0075446, entitled "Surgical Staple Assembly with Hemostatic Feature," published Mar. 28, 2013, issued as U.S. Pat. No. 9,393,018 on Jul. 19, 2016, the disclosure of which is incorporated by reference herein; U.S. Patent Pub. No. 2013/0062394, entitled "Surgical Staple Cartridge with Self-Dispensing Staple Buttress," published Mar. 14, 2013, issued as U.S. Pat. No. 9,101,359 on Aug. 11, 2015, the disclosure of which is incorporated by reference herein; U.S. Patent Pub. No. 2013/0075445, entitled "Anvil Cartridge for Surgical Fastening Device," published Mar. 28, 2013, issued as U.S. Pat. No. 9,198,644 on Dec. 1, 2015, the disclosure of which is incorporated by reference herein; U.S. Patent Pub. No. 2013/0075447, entitled "Adjunct Therapy for Applying Hemostatic Agent," published Mar. 28, 2013, now abandoned, the disclosure of which is incorporated by reference herein; U.S. Patent Pub. No. 2013/0256367, entitled "Tissue Thickness Compensator Comprising a Plurality of Medicaments," published Oct. 3, 2013, issued as U.S. Pat. No. 9,211,120 on Dec. 15, 2015, the disclosure of which is

incorporated by reference herein; U.S. patent application Ser. No. 14/300,954, entitled "Adjunct Materials and Methods of Using Same in Surgical Methods for Tissue Sealing," filed Jun. 10, 2014, issued as U.S. Pat. No. 10,172,611 on Jan. 8, 2019, the disclosure of which is incorporated by reference herein; U.S. patent application Ser. No. 14/827,856, entitled "Implantable Layers for a Surgical Instrument," filed Aug. 17, 2015, published as U.S. Pub. No. 2017/0049444 on Feb. 23, 2017, the disclosure of which is incorporated by reference herein; U.S. patent application Ser. No. 14/840,613, entitled "Drug Eluting Adjuncts and Methods of Using Drug Eluting Adjuncts," filed Aug. 31, 2015, published as U.S. Pub. No. 2017/0055986 on Mar. 2, 2017, the disclosure of which is incorporated by reference herein; U.S. patent application Ser. No. 14/871,071, entitled "Compressible Adjunct with Crossing Spacer Fibers," filed Sep. 30, 2015, published as U.S. Pat. No. 2017/0086837 on Mar. 30, 2017, the disclosure of which is incorporated by reference herein; and/or U.S. patent application Ser. No. 14/871,131, entitled "Method for Applying an Implantable Layer to a Fastener Cartridge," filed Sep. 30, 2015, published as U.S. Pub. No. 2017/0086842 on Mar. 30, 2017, the disclosure of which is incorporated by reference herein.

In the present example, adhesive layer (**104**) is provided on buttress body (**102**) in order to adhere buttress body (**102**) to underside (**65**) of anvil (**60**). Similarly, adhesive layer (**114**) is provided on buttress body (**112**) in order to adhere buttress body (**112**) to deck (**73**) of staple cartridge (**70**). Adherence of the buttress body (**102**) to underside (**65**) of anvil (**60**) or to deck (**73**) of staple cartridge (**70**) can occur through a variety of mechanisms including but not limited to a pressure sensitive adhesive. In some versions, each adhesive layer (**104**, **114**) comprise a pressure sensitive adhesive material. Examples of various suitable materials that may be used to form adhesive layers (**104**, **114**) are disclosed in U.S. patent application Ser. No. 14/667,842, entitled "Method of Applying a Buttress to a Surgical Stapler," filed Mar. 25, 2015, published as U.S. Pub. No. 2016/0278774 on Sep. 29, 2016, the disclosure of which is incorporated by reference herein. Alternatively, any other suitable materials may be used. It should be understood that the term "adhesive," as used herein, may include (but is not limited to) tacky materials and also materials that are pliable or wax-like and adhere to a complex geometry via deformation and conformance. Some suitable adhesives may provide such pliability to adhere to a complex geometry via deformation and conformance without necessarily providing a high initial tack. In some instances, adhesives with lower tackiness may be removed more cleanly from surfaces. Various suitable materials that may be used to form adhesive layers (**104**, **114**) will be apparent to those of ordinary skill in the art in view of the teachings herein.

B. Exemplary Materials and Techniques for Providing Adhesion of Buttress to Surgical Stapler

As noted above, a buttress assembly (**100**, **110**) may include a layer (**104**, **114**) of adhesive material (or other form of adhesive material) that adheres buttress body (**102**, **112**) to either underside (**65**) of anvil (**60**) or deck (**73**) of staple cartridge (**70**). Such an adhesive material may provide proper positioning of buttress body (**102**, **112**) before and during actuation of end effector (**40**); then allow buttress body (**102**, **112**) to separate from end effector (**40**) after end effector (**40**) has been actuated, without causing damage to buttress body (**102**, **112**) that is substantial enough to compromise the proper subsequent functioning of buttress body (**102**, **112**).

FIGS. **5**A-**5**C show a sequence where an end effector (**40**) that has been loaded with buttress assemblies (**100**, **110**) is actuated to drive staples (**90**) through two apposed layers of tissue (T_1, T_2), with buttress assemblies (**100**, **110**) being secured to the same layers of tissue (T_1, T_2) by staples (**90**). In particular, FIG. **5**A shows layers of tissue (T_1, T_2) positioned between anvil (**60**) and staple cartridge (**70**), with anvil (**60**) in the open position. Buttress assembly (**100**) is adhered to the underside (**65**) of anvil (**60**) via adhesive layer (**104**); while buttress assembly (**110**) is adhered to deck (**73**) of staple cartridge (**70**) via adhesive layer (**114**). Layers of tissue (T_1, T_2) are thus interposed between buttress assemblies (**100**, **110**). Next, trigger (**24**) is pivoted toward pistol grip (**22**) to drive closure tube (**32**) and closure ring (**36**) distally. This drives anvil (**60**) to the closed position as shown in FIG. **5**B. At this stage, layers of tissue (T_1, T_2) are compressed between anvil (**60**) and staple cartridge (**70**), with buttress assemblies (**100**, **110**) engaging opposite surfaces of tissue layers (T_1, T_2). End effector (**40**) is then actuated as described above, driving staple (**90**) through buttress assemblies (**100**, **110**) and tissue (**90**). As shown in FIG. **5**C, crown (**92**) of driven staple (**90**) captures and retains buttress assembly (**110**) against layer of tissue (T_2). Deformed legs (**94**) of staple (**90**) capture and retain buttress assembly (**100**) against layer of tissue (T_1).

It should be understood that a series of staples (**90**) will similarly capture and retain buttress assemblies (**100**, **110**) against layers of tissue (T_1, T_2), thereby securing buttress assemblies (**100**, **110**) to tissue (T_1, T_2) as shown in FIG. **6**. As end effector (**40**) is pulled away from tissue (**90**) after deploying staples (**90**) and buttress assemblies (**100**, **110**), buttress assemblies (**100**, **110**) disengage end effector), such that buttress assemblies (**100**, **110**) remain secured to tissue (T_1, T_2) with staples (**90**). Buttress tissue (T_1, T_2) thus provide structural reinforcement to the lines of staples (**90**). As can also be seen in FIG. **6**, knife member (**80**) also cuts through a centerline of buttress tissue assemblies (**100**, **110**), separating each buttress assemblies (**100**, **110**) into a corresponding pair of sections, such that each section remains secured to a respective severed region of tissue (T_1, T_2).

In the foregoing example, buttress assembly (**100**) is sized to span across the full width of underside (**65**), such that buttress assembly (**100**) spans across channel (**62**). Thus, knife member (**80**) cuts through buttress assembly (**100**) during actuation of end effector (**40**) as described above. In some other examples, such as those described below, buttress assembly (**100**) is provided in two separate, laterally spaced apart portions, with one portion being disposed on underside (**65**) on one side of channel (**62**) and another portion being disposed on underside (**65**) on the other side of channel (**62**). In such versions, buttress assembly (**100**) does not span across channel (**62**), such that knife member (**80**) does not cut through buttress assembly (**100**) during actuation of end effector (**40**).

Likewise, buttress assembly (**110**) may be sized to span across the full width of deck (**73**), such that buttress assembly (**110**) spans across channel (**72**), and such that knife member (**80**) cuts through buttress assembly (**110**) during actuation of end effector (**40**) as described above. Alternatively, buttress assembly (**110**) may be provided in two separate, laterally spaced apart portions, with one portion being disposed on deck (**73**) on one side of channel (**72**) and another portion being disposed on deck (**73**) on the other side of channel (**72**), such that buttress assembly (**110**) does not span across channel (**72**), and such that knife member (**80**) does not cut through buttress assembly (**110**) during actuation of end effector (**40**).

III. Exemplary Stretchable Buttress Assembly for Surgical Stapler

In some instances, it may be desirable to equip end effector (**40**) with a buttress assembly (**100**, **110**) comprising a buttress body (**102**, **112**) that includes an elastic material that is substantially stretchable in at least one direction and that will substantially recover its original shape. The resulting buttress assemblies (**100**, **110**) may advantageously reinforce the mechanical fastening of tissue provided by staples (**90**), while moving with, rather than restraining, the underlying tissue. Such buttress assemblies (**100**, **110**) may be particularly useful in applications in which the tissue that is fastened may subsequently expand and/or contract. For example, stretchable buttress assemblies (**100**, **110**) may be of use to reinforce the mechanical fastening of a collapsed lung that is then re-inflated, and expands and contracts with the lung during the breathing process.

In some instances where staples (**90**) are to applied to an anatomical structure that expands and contracts during normal biological functioning (e.g., a lung, etc.), end effector (**40**) may be modified to apply lines of staples (**90**) to tissue (T_1, T_2) that are also configured to allow stretching of tissue (T_1, T_2). For instance, such a modified end effector (**40**) may be constructed and operable in accordance with at least some of the teachings of U.S. patent application Ser. No. 14/498,145, entitled "Method for Creating a Flexible Staple Line," filed Sep. 26, 2014, published as U.S. Pub. No. 2016/0089142 on Mar. 31, 2016, the disclosure of which is incorporated by reference herein; and/or U.S. patent application Ser. No. 14/498,070, entitled "Radically Expandable Staple Line," filed Sep. 26, 2014, published as U.S. Pub. No. 2016/0089146 on Mar. 31, 2016, the disclosure of which is incorporated by reference herein. It should be understood that the following variations of buttress body (**102**, **112**) may be used with end effector (**40**) described above, with the variation of end effector (**40**) described in U.S. patent application Ser. No. 14/498,145, published as U.S. Pub. No. 2016/0089142 on Mar. 31, 2016, and/or U.S. patent application Ser. No. 14/498,070, published as U.S. Pub. No. 2016/0089146 on Mar. 31, 2016, and/or with any other suitable form of end effector (**40**).

In illustrative examples of stretchable buttresses assemblies (**100**, **110**), the buttress bodies (**102**, **112**) may comprise fibrous, planar fabric. "Fiber" as used herein means continuous fibers, which are sometimes referred to in the art as "substantially continuous filaments," "filaments," or "yarn," or staple fibers having an average length that is sufficient so that the staple fibers may be knitted and/or woven together. Fibers that are useful may be selected from the group consisting of: monocomponent fibers; multicomponent fibers; bicomponent fibers; biconstituent fibers; and combinations thereof.

"Monocomponent fiber" as used herein, refers to a fiber formed from using one or more extruders from only one polymer; this is not meant to exclude fibers formed from one polymer to which small amounts of additives have been added. Additives may be added to the polymer for the purposes of providing the resulting fiber with coloration, antistatic properties, lubrication, hydrophilicity, and/or other properties.

"Multicomponent fiber" as used herein, refers to a fiber formed from two or more different polymers that are extruded from separate extruders and spun together to form one fiber.

"Bicomponent fibers" are one type of multicomponent fiber, and are formed from two different polymers. Bicomponent fibers may sometimes be referred to in the art as "conjugate fibers." Bicomponent fibers may be comprised of polymers that are substantially continuously positioned in distinct zones, both across the cross-section of the bicomponent fibers and along their length. Non-limiting examples of such bicomponent fibers include, but are not limited to: sheath/core arrangements, wherein one polymer is surrounded by another; side-by-side arrangements; segmented pie arrangements; or even "islands-in-the-sea" arrangements. Each of the aforementioned polymer arrangements is known in the art of multicomponent (including bicomponent) fibers.

Bicomponent fibers can be splittable fibers. Such fibers are capable of being split lengthwise before or during processing into multiple fibers with each of the multiple fibers having a smaller cross-sectional dimension than that of the original bicomponent fiber. Splittabie fibers may provide softer fabrics due to their reduced cross-sectional dimensions.

"Biconstituent fibers" as used herein, refers to fibers which have been formed from at least two starting polymers extruded as a blend from the same extruder. Biconstituent fibers may have the various polymer components arranged in relatively constantly positioned distinct zones across the cross-sectional area of the fiber, and the various polymers are usually not continuous along the entire length of the fiber. In the alternative, biconstituent fibers may comprise a blend, that may be homogeneous or otherwise, of the at least two starting polymers. For example, a bicomponent fiber may be formed from starting polymers which differ only in molecular weight.

Biconstituent fibers may form fibrils, which may begin and end at random along the length of the fiber. Biconstituent fibers may sometimes be referred to as multiconstituent fibers.

In illustrative examples of stretchable buttresses assemblies (**100**, **110**), planar fabrics that are useful to make stretchable buttress assemblies (**100**, **110**) comprise fibers that are substantially aligned in one or more preferred directions, such as in the fabric's machine direction, cross-machine direction, or combinations thereof. Useful fabrics may be distinguished from fabric that comprises fibers in random orientations, including but not limited to, melt blown, hydroentangled, and electrospun fabrics. The following provides several merely illustrative examples of fiber arrangements that may be readily incorporated into buttress assemblies (**100**, **110**). It should therefore be understood that the following teachings may be readily combined with the teachings above. It should also be understood that some versions of the following examples include a combination of elastic fibers and non-elastic fibers.

In some surgical applications, it may be desirable to utilize buttress assemblies (**100**, **110**) comprising buttress bodies (**102**, **112**) that do not substantially stretch along the longitudinal axis (LA) of end effector (**40**) (along which the length of each buttress body (**102**, **112**) runs); but that do stretch laterally along the plane defined by each buttress body (**102**, **112**). In other words, it may be desirable to provide buttress bodies (**102**, **112**) that stretch along the dimension of the width of buttress bodies (**102**, **112**). For example, a surgeon may wish to staple an anatomical structure that is not intended to stretch once fastened with an extensible staple line. However, the surgeon may not wish to stop mid-surgery and exchange instrument (**10**) and/or shaft assembly (**30**). By applying to the anatomical structure a buttress assembly (**100**, **110**) that does not substantially stretch along the longitudinal axis (LA) of end effector (**40**),

the stretch of the staple line may be minimized or even eliminated. In an illustrative example, during a lobectomy, a surgeon may wish to apply an extensible staple line to the lung parenchyma but apply a non-extensible staple line to the bronchus. In such settings, the surgeon may apply an extensible staple line without buttress assembly (**100**, **110**) to the parenchyma; then apply an extensible staple line with buttress assembly (**100**, **110**) to the bronchus. The presence of the applied, non-longitudinally-extensible buttress assembly (**100**, **110**) will essentially convert an otherwise extensible staple line into a non-extensible staple line as applied to the bronchus.

In some other surgical applications, it may be desirable to utilize buttress assemblies (**100**, **110**) comprising buttress bodies (**102**, **112**) that do stretch along the longitudinal axis (LA) of end effector (**40**); but that do not substantially stretch laterally along the plane defined by each buttress body (**102**, **112**). In other words, it may be desirable to provide buttress bodies (**102**, **112**) that stretch along the dimension of the length of buttress bodies (**102**, **112**). Referring back to the example of a lung lobectomy, the lung may be in a collapsed state when the surgeon actuates end effector (**40**) on the parenchyma of the lung. When the lung is later reinflated, the resulting expansion of the lunch will apply tension in the parenchyma, thereby providing extension along the staple line. An extensible staple line (e.g., as taught in U.S. patent application Ser. No. 14/498,145, published as U.S. Pub. No. 2016/0089142 on Mar. 31, 2016, and/or U.S. patent application Ser. No. 14/498,070, published as U.S. Pub. No. 2016/0089146 on Mar. 31, 2016) may thus accommodate such extension. In settings where the surgeon wishes for that staple line to be reinforced by a buttress assembly (**100**, **110**), that buttress assembly (**100**, **110**) may need to be extensible along the longitudinal axis in order to accommodate the expansion of the lung during reinflation. Otherwise, a non-extensible buttress assembly (**100**, **110**) may create stress at the staple line during reinflation, possibly tearing tissue, compromising the integrity of the staple line, resulting in leaks, and/or providing other adverse results. Thus, buttress bodies (**102**, **112**) that substantially stretch along the longitudinal axis (LA) of end effector (**40**) may be needed.

The following examples relate to various woven or knit configurations that may be provided in fabrics that are used to form buttress bodies (**102**, **112**). In the following examples, such buttress bodies (**102**, **112**) may be formed and oriented such that they provide a stretch axis that is parallel to the longitudinal axis (LA) of end effector (**40**) (i.e., such that buttress bodies (**102**, **112**) provide a stretch axis that extends along the length of buttress bodies (**102**, **112**)). Alternatively, such buttress bodies (**102**, **112**) may be formed and oriented such that they provide a stretch axis that is perpendicular to the longitudinal axis (LA) of end effector (**40**) (i.e., such that buttress bodies (**102**, **112**) provide a stretch axis that extends across the width of buttress bodies (**102**, **112**)). As yet another alternative, buttress bodies (**102**, **112**) may be formed and oriented such that they provide a stretch axis that is otherwise oriented in relation to the longitudinal axis (LA) of end effector (**40**).

In the present example, variations of buttress bodies (**102**, **112**) are formed by a combination of elastic fibers and non-elastic fibers, all of which are arranged in a repeatable pattern. The elastic fibers are oriented along the stretch axis and the non-elastic fibers are oriented transversely relative to the stretch axis. It should be understood that the stretchability of elastic versions of buttress bodies (**100**, **110**) may be manipulated based upon the choice of fiber material, the orientation of the fibers, tension on the fibers during fabric production, and various other factors.

By way of example only, the planar fabric may comprise elastic, i.e., extensible, fibers made from polymers selected from the group consisting of: poly(caprolactone)-co-poly (glycolide) (PCL/PGA); poly(caprolactone)-co-poly(lactide) (PCL/PLA); poly(lactide)-co-trimethylene carbonate (PCL/TMC); poly(p-dioxanone) (PDS); polyglactin 910 polymer mesh; and combinations thereof. Other suitable materials that may be used to form elastic fibers will be apparent to those of ordinary skill in the art in view of the teachings herein. Similarly, various suitable materials that may be used to form the non-elastic fibers will be apparent to those of ordinary skill in the art in view of the teachings herein. Non-elastic, i.e. non-extensible, fibers may be made from polymers selected from the group consisting of: poly (caprolactone)-co-poly(glycolide) (PCL/PGA); poly(caprolactone)-co-poly(lactide) (PCL/PLA); poly(lactide)-co-trimethylene carbonate (PCL/TMC); poly(p-dioxanone) (PDS); polyglactin 910 polymer mesh; polyglycolide (PGA) felt (for example, Neoveil™ felt from Gunze Limited (Kyoto, Japan)); a microporous structure of polyglycolic acid:trimethylcarbonate (PGA:TMC) (for example, Gore® Seamguard® from W.L. Gore & Associates, Inc. (Newark, Del.)); and combinations thereof. It should also be understood that the elastic fibers and the non-elastic fibers may each comprise multifilament fiber, monofilament fiber, or combinations thereof. The relative geometries and constructions of different fibers may be used to change the relative extensibility of the fibers.

In some versions, an elastic planar fabric that is used to form buttress bodies (**102**, **112**) comprises woven fiber structures. Woven fiber structures comprise crossed warp and weft fibers. The warp and weft fibers may be perpendicular to each other, such that they intersect at about a 90° angle. The stretchability of woven fabrics may be more material dependent than pattern dependent. However, woven fabrics may comprise less extensible structures compared to knits. Using an elastomeric yarn in the filling may improve the stretch and recovery of the woven fabrics, in which case, extensibility would likely occur mainly in the cross direction.

In some examples, woven fiber fabrics may preferably comprise monocomponent fibers that are either multifilament or monofilament and of relatively fine denier with a low denier per filament (DPF). In some examples, both multifilament and monofilament fibers may be used in the same buttress construct. In some examples, two or more monocomponent fibers of different polymer composition may be used to achieve desired buttress body properties.

Useful planar fabrics may be woven in any pattern that provides for substantial stretchability in at least one direction (i.e., along a stretch axis) and substantial recovery of the fabric's original shape after being stretched. By way of example only, the planar fabric may be woven in a pattern selected from the group consisting of: twill weave; plain weave; satin weave; and combinations thereof. More particularly, the planar fabric may comprise more than one woven pattern; indeed, while the twill pattern, plain weave pattern, etc. comprise basic arrangements of warp and fill yarns (i.e. weft yarns), any number of desirable designs can be produced by altering the location and frequency of interlacing.

FIG. **7** is a diagram depicting a weave pattern of an exemplary planar fabric (**200**) that comprises fibers (**210**, **220**) that have been woven such that the warp fibers (**210**) and weft fibers (**220**) intersect at angles of about 90°. In this

example, warp fibers (**210**) are formed of a non-elastic material while weft fibers (**220**) are formed of an elastic material. Warp fibers (**210**) are arranged in parallel along the machine direction (MD) and perpendicular to the cross-machine direction (CD) of planar fabric (**200**). Warp fibers (**210**) are also perpendicular to the stretch axis (SA). Weft fibers (**220**) are inserted in the transverse direction, parallel to cross-machine direction (CD) of the planar fabric (**200**) and perpendicular to the warp fibers (**210**). Weft fibers (**220**) are thus parallel to the stretch axis (SA). Thus, with respect to the planar fabric (**200**) machine direction (MD), warp fibers (**210**) are longitudinally oriented, whereas weft fibers (**220**) are transversely oriented. The weave pattern of elastic weft fibers (**220**) is configured to enable stretching of planar fabric (**200**) along the stretch axis (SA). Planar fabric (**200**) is thus extensible despite the fact that planar fabric (**200**) includes non-elastic warp fibers (**210**).

FIG. **8** shows an illustrative example of a buttress body (**250**) that comprises the woven planar fabric (**200**) of FIG. **7**, wherein the planar fabric (**200**) is oriented in such a way that the warp fibers (**210**) and weft fibers (**220**) intersect the stretch axis (SA) of the buttress body (**250**) at an angle of about 45°. Buttress body (**250**) is shown in a both a relaxed state (**250***a*) and a stretched state (**250***b*). In particular, buttress body (**250**) is shown as being stretchable along stretch axis (SA). In some versions, the stretch axis (SA) is parallel to the longitudinal axis (LA) of end effector (**40**). In some other versions, the stretch axis (SA) is perpendicular to the longitudinal axis (LA) of end effector (**40**). In still other versions, the stretch axis (SA) has some other angular relationship with the longitudinal axis (LA) of end effector (**40**). It should be understood that buttress body (**250**) may be secured to end effector (**40**) and originally applied to tissue (T_1, T_2) while buttress body (**250**) is in a relaxed, non-stretched state as is the case with buttress body (**250***a*). In other words, in the present example, buttress body (**250**) only reaches the stretched state (**250***b*) after buttress body (**250**) has been secured to tissue (T_1, T_2) by staples (**90**). Buttress body (**250**) would reach the stretched state (**250***b*) to accommodate stretching of tissue (T_1, T_2). However, the stretching of buttress body (**250**) would not adversely impact the securing and sealing of tissue (T_1, T_2) provided by staples (**90**) and buttress body (**250**).

It should be understood that planar fabric (**200**) may be modified in various ways. The performance of buttress body (**250**) may nevertheless be substantially the same despite variations in the configuration of planar fabric (**200**). For instance, some other versions of planar fabric (**200**) comprise a warp knit, weft-inserted fabric. For example, fibers may be knitted in a Raschel weft-insertion pattern using any number of suitable needle beds and guide bars. In some illustrative embodiments, one or two needle beds and four to eight guide bars may be utilized.

FIG. **9** is a diagram depicting an exemplary planar fabric (**300**) having a Raschel weft-insertion pattern of fibers. Planar fabric (**300**) comprises warp fibers (**310**) that have been formed into columns of pillars produced by interlooping the warp fibers (**310**) to form a chain stitch, and by laying in weft fibers (**320**) to connect the columns of pillars together and form the fabric design. The resulting planar fabric (**300**) may be substantially stable in both the machine direction (MD) and cross-machine direction (CD), unless the weft fibers (**320**) are elastomeric, in which case, the resulting planar fabric (**300**) will substantially stretch in the cross machine direction (CD). In other words, if the weft fibers (**320**) are elastomeric, the stretch axis (SA) of the planar fabric (**300**) may be perpendicular to its machine direction (MD). In some versions, the planar fabric (**300**) may substantially recover its original shape after it has been stretched.

In still other variations of the planar fabric (**300**) depicted in FIG. **9**, a non-elastic fiber is wrapped around an elastic fiber to form a coil-like spring around a stretchable center. The resulting combination of fibers may then be used as the weft fibers (**320**) that are laid in to form the design and connect the columns of pillars of warp fibers (**310**) together as shown in FIG. **10**.

The foregoing examples include configurations where elastic fibers are combined with non-elastic fibers to form planar fabric (**200**) that is used to form buttress bodies (**102**, **112**). As yet another merely illustrative variation, planar fabric (**200**) may be formed entirely of non-elastic fibers yet may still provide extensibility along a stretch axis. For instance, planar fabric (**200**) may comprise non-elastic fibers that are pre-kinked (e.g., into the shape of a coil spring, zigzag pattern, or some other configuration) to reduce the effective length of the non-elastic fibers. When such non-elastic fibers are pulled longitudinally, the kinks or bends in the non-elastic fibers may accommodate elongation of the effective length of the non-elastic fibers. Moreover, the kinked or otherwise bent non-elastic fibers may provide a resilient bias such that the non-elastic fibers are biased to provide the shorter effective length.

In some versions of planar fabric (**200**) that are formed entirely of non-elastic fibers, the non-elastic fibers may be provided as yarns that are woven or knitted into a pre-existing fibrous structure. For instance, the kinked or otherwise bent non-elastic fibers may be woven or knitted into a pre-existing, stretchable sheet of fabric. The kinked or otherwise bent non-elastic fibers may impart a resilient bias to the pre-existing, stretchable sheet of fabric along the stretch axis (SA); yet may still enable the resulting assembly to be extensible along the stretch axis (SA).

Those of ordinary skill in the art will recognize that there are various ways in which non-elastic fibers may be pre-kinked, pre-bent, or otherwise manipulated to provide the properties described above. For instance, such non-elastic fibers may be texturized through airjet entanglement. Alternatively, non-elastic fibers may be mechanically texturized (e.g., using geared rollers, etc.). As yet another merely illustrative example, the non-elastic fibers may be knitted into a knitted arrangement, then de-knitted from that arrangement. In some such versions, the non-elastic fibers are knitted into a fabric and heat set. The heat set may impart the kinked or bent configuration to the non-elastic fibers. After the heat set is performed, the fabric is unraveled, with the non-elastic fibers retaining a kinked or bent configuration due to the heat set. Still other suitable techniques that may be used to pre-kink, pre-bend, or otherwise manipulate non-elastic fibers to provide the properties described above will be apparent to those of ordinary skill in the art in view of the teachings herein.

In addition to the foregoing, it should also be understood that any of the various buttress assemblies described herein may be further constructed and operable in accordance with at least some of the teachings of U.S. patent application Ser. No. 14/667,842, entitled "Method of Applying a Buttress to a Surgical Stapler," filed Mar. 25, 2015, published as U.S. Pub. No. 2016/0278774 on Sep. 29, 2016, the disclosure of which is incorporated by reference herein.

IV. Exemplary Combinations

The following examples relate to various non-exhaustive ways in which the teachings herein may be combined or

applied. It should be understood that the following examples are not intended to restrict the coverage of any claims that may be presented at any time in this application or in subsequent filings of this application. No disclaimer is intended. The following examples are being provided for nothing more than merely illustrative purposes. It is contemplated that the various teachings herein may be arranged and applied in numerous other ways. It is also contemplated that some variations may omit certain features referred to in the below examples. Therefore, none of the aspects or features referred to below should be deemed critical unless otherwise explicitly indicated as such at a later date by the inventors or by a successor in interest to the inventors. If any claims are presented in this application or in subsequent filings related to this application that include additional features beyond those referred to below, those additional features shall not be presumed to have been added for any reason relating to patentability.

Example 1

A stretchable buttress assembly for reinforcing the mechanical fastening of tissue by surgical staples that are deployable from a surgical stapler, the buttress assembly comprising: (a) a planar fabric layer having a first side and a second side opposite the first side, wherein the planar fabric layer is configured to stretch along a stretch axis, wherein the planar fabric layer comprises: (i) a plurality of extensible fibers arranged in a repeatable pattern, wherein the extensible fibers are oriented along respective paths that are each parallel to the stretch axis, and (ii) a plurality of non-extensible fibers arranged in a repeatable pattern and engaged with the extensible fibers; and (b) a biocompatible adhesive layer, wherein the adhesive layer is applied to the first side of the planar fabric and is configured to removably adhere the planar fabric layer to an end effector of a surgical stapler.

Example 2

The stretchable buttress assembly of Example 1, wherein the plurality of non-extensible fibers are oriented transversely to the stretch axis.

Example 3

The stretchable buttress assembly of any one or more of Examples 1 through 2, wherein the extensible fibers are selected from the group consisting of: monocomponent fibers; multicomponent fibers; bicomponent fibers; biconstituent fibers; and combinations thereof.

Example 4

The stretchable buttress assembly of Example 3, wherein the extensible fibers comprise polymers selected from the group consisting of: poly(caprolactone)-co-poly(glycolide) (PCL/PGA); poly(caprolactone)-co-poly(lactide) (PCL/PLA); poly(lactide)-co-trimethylene carbonate (PCL/TMC); poly(p-dioxanone) (PDS); polyglactin 910; and combinations thereof.

Example 5

The stretchable buttress assembly of any one or more of Examples 1 through 4, wherein the non-extensible fibers are selected from the group consisting of: monocomponent fibers; multicomponent fibers; bicomponent fibers; biconstituent fibers; and combinations thereof.

Example 6

The stretchable buttress assembly of Example 5, wherein the non-extensible fibers comprise polymers selected from the group consisting of: poly(caprolactone)-co-poly(glycolide) (PCL/PGA); poly(caprolactone)-co-poly(lactide) (PCL/PLA); poly(lactide)-co-trimethylene carbonate (PCL/TMC); poly(p-dioxanone) (PDS); polyglactin 910; polyglycolide (PGA); polyglycolic acid:trimethylcarbonate (PGA:TMC); and combinations thereof.

Example 7

The stretchable buttress assembly of any one or more of Examples 1 through 6, wherein the non-extensible fibers and extensible fibers are woven together in a pattern selected from the group consisting of: twill weave; plain weave; satin weave; and combinations thereof.

Example 8

The stretchable buttress assembly of any one or more of Examples 1 through 7, wherein the non-extensible fibers and extensible fibers are knitted together in a Raschel weft-insertion pattern.

Example 9

The stretchable buttress assembly of Example 8, wherein the extensible fibers are bicomponent fibers comprising non-elastic fibers wrapped around elastic fibers.

Example 10

A stretchable buttress assembly for reinforcing the mechanical fastening of tissue by surgical staples that are deployable from a surgical stapler, the buttress assembly comprising: (a) a planar fabric layer having a first side and a second side opposite the first side, wherein the planar fabric layer is configured to stretch along a stretch axis, wherein the planar fabric layer comprises: (i) a plurality of pre-kinked non-extensible fibers arranged in a repeatable pattern and oriented along respective paths that are each parallel to the stretch axis, and (ii) a plurality of non-extensible fibers arranged in a repeatable pattern and engaged with the extensible fibers; and (b) a biocompatible adhesive layer, wherein the adhesive layer is applied to the first side of the planar fabric and is configured to removeably adhere the planar fabric layer to an end effector of a surgical stapler.

Example 11

A method of using a surgical stapler with a buttress assembly, wherein the surgical stapler comprises an end effector having a staple cartridge and an anvil, wherein the buttress assembly comprises a planar fabric layer and an adhesive layer, wherein the planar fabric layer comprises a plurality of extensible fibers and a plurality of non-extensible fibers wherein the plurality of extensible fibers and the plurality of non-extensible fibers are each arranged in a repeatable pattern, and wherein the non-extensible fibers are configured to cooperate with the extensible fibers to enable the buttress assembly to stretch along a stretch axis, the

method comprising: (a) adhering the buttress assembly to the anvil or the staple cartridge; (b) engaging the tissue between the anvil and the staple cartridge of the end effector; (c) deploying staples from the staple cartridge through the buttress assembly and tissue; and (d) disengaging the end effector such that the buttress assembly remains secured to the tissue by the staples, wherein the buttress assembly is configured to accommodate stretching in the tissue.

Example 12

The method of Example 11, wherein the stretch axis of the buttress assembly is parallel to a longitudinal axis of the end effector.

Example 13

The method of any one or more of Examples 11 through 12, wherein the stretch axis of the buttress assembly is perpendicular to a longitudinal axis of the end effector.

Example 14

The stretchable buttress assembly of any one or more of Examples 11 through 13, wherein the extensible fibers are selected from the group consisting of: monocomponent fibers; multicomponent fibers; bicomponent fibers; biconstituent fibers; and combinations thereof.

Example 15

The stretchable buttress assembly of Example 14, wherein the extensible fibers comprise polymers selected from the group consisting of: poly(caprolactone)-co-poly(glycolide) (PCL/PGA); poly(caprolactone)-co-poly(lactide) (PCL/PLA); poly(lactide)-co-trimethylene carbonate (PCL/TMC); poly(p-dioxanone) (PDS); polyglactin 910; and combinations thereof.

Example 16

The stretchable buttress assembly of any one or more of Examples 11 through 15, wherein the non-extensible fibers are selected from the group consisting of: monocomponent fibers; multicomponent fibers; bicomponent fibers; biconstituent fibers; and combinations thereof.

Example 17

The stretchable buttress assembly of Example 16, wherein the non-extensible fibers comprise polymers selected from the group consisting of: poly(caprolactone)-co-poly(glycolide) (PCL/PGA); poly(caprolactone)-co-poly(lactide) (PCL/PLA); poly(lactide)-co-trimethylene carbonate (PCL/TMC); poly(p-dioxanone) (PDS); polyglactin 910; polyglycolide (PGA); polyglycolic acid:trimethylcarbonate (PGA:TMC); and combinations thereof.

Example 18

The stretchable buttress assembly of any one or more of Examples 11 through 18, wherein the non-extensible fibers and extensible fibers are woven together in a pattern selected from the group consisting of: twill weave; plain weave; satin weave; and combinations thereof.

Example 19

The stretchable buttress assembly of any one or more of Examples 11 through 18, wherein the non-extensible fibers and extensible fibers are knitted together in a Raschel weft-insertion pattern.

Example 20

The stretchable buttress assembly of Example 19, wherein the extensible fibers are bicomponent fibers comprising non-elastic fibers wrapped around elastic fibers.

V. Miscellaneous

It should be understood that any one or more of the teachings, expressions, embodiments, examples, etc. described herein may be combined with any one or more of the other teachings, expressions, embodiments, examples, etc. that are described herein. The above-described teachings, expressions, embodiments, examples, etc. should therefore not be viewed in isolation relative to each other. Various suitable ways in which the teachings herein may be combined will be readily apparent to those of ordinary skill in the art in view of the teachings herein. Such modifications and variations are intended to be included within the scope of the claims.

In addition to the foregoing, it should also be understood that any of the various buttress assemblies described herein may be further constructed and operable in accordance with at least some of the teachings of U.S. patent application Ser. No. 14/667,842, entitled "Method of Applying a Buttress to a Surgical Stapler," filed Mar. 25, 2015, published as U.S. Pub. No. 2016/0278774 on Sep. 29, 2016, the disclosure of which is incorporated by reference herein; U.S. patent application Ser. No. 14/827,856, entitled "Implantable Layers for a Surgical Instrument," filed Aug. 17, 2015, published as U.S. Pub. No. 2017/0049444 on Feb. 23, 2017, the disclosure of which is incorporated by reference herein; U.S. patent application Ser. No. 14/871,071, entitled "Compressible Adjunct with Crossing Spacer Fibers," filed Sep. 30, 2015, published as U.S. Pub. No. 2017/0086837 on Mar. 30, 2017, the disclosure of which is incorporated by reference herein; and U.S. patent application Ser. No. 14/871,131, entitled "Method for Applying an Implantable Layer to a Fastener Cartridge," filed Sep. 30, 2015, published as U.S. Pub. No. 2017/0086842 on Mar. 30, 2017, the disclosure of which is incorporated by reference herein. Furthermore, in addition to the methods described herein, any of the various buttress assemblies described herein may be applied to end effector (**40**) in accordance with at least some of the teachings of U.S. Provisional Patent App. No. 62/209,041, entitled "Method and Apparatus for Applying a Buttress to End Effector of a Surgical Stapler," filed Aug. 24, 2015, the disclosure of which is incorporated by reference herein; and/or U.S. patent application Ser. No. 14/871,131, entitled "Method for Applying an Implantable Layer to a Fastener Cartridge," filed Sep. 30, 2015, published as U.S. Pub. No. 2017/00868842 on Mar. 30, 2017, the disclosure of which is incorporated by reference herein. Various suitable ways in which the teachings herein may be combined with various teachings of the above-cited references will be apparent to those of ordinary skill in the art.

It should be appreciated that any patent, publication, or other disclosure material, in whole or in part, that is said to be incorporated by reference herein is incorporated herein only to the extent that the incorporated material does not

conflict with existing definitions, statements, or other disclosure material set forth in this disclosure. As such, and to the extent necessary, the disclosure as explicitly set forth herein supersedes any conflicting material incorporated herein by reference. Any material, or portion thereof, that is said to be incorporated by reference herein, but which conflicts with existing definitions, statements, or other disclosure material set forth herein will only be incorporated to the extent that no conflict arises between that incorporated material and the existing disclosure material.

Versions of the devices described above may have application in conventional medical treatments and procedures conducted by a medical professional, as well as application in robotic-assisted medical treatments and procedures. By way of example only, various teachings herein may be readily incorporated into a robotic surgical system such as the DAVINCI™ system by Intuitive Surgical, Inc., of Sunnyvale, Calif. Similarly, those of ordinary skill in the art will recognize that various teachings herein may be readily combined with various teachings of any of the following: U.S. Pat. No. 5,792,135, entitled "Articulated Surgical Instrument For Performing Minimally Invasive Surgery With Enhanced Dexterity and Sensitivity," issued Aug. 11, 1998, the disclosure of which is incorporated by reference herein; U.S. Pat. No. 5,817,084, entitled "Remote Center Positioning Device with Flexible Drive," issued Oct. 6, 1998, the disclosure of which is incorporated by reference herein; U.S. Pat. No. 5,878,193, entitled "Automated Endoscope System for Optimal Positioning," issued Mar. 2, 1999, the disclosure of which is incorporated by reference herein; U.S. Pat. No. 6,231,565, entitled "Robotic Arm DLUS for Performing Surgical Tasks," issued May 15, 2001, the disclosure of which is incorporated by reference herein; U.S. Pat. No. 6,783,524, entitled "Robotic Surgical Tool with Ultrasound Cauterizing and Cutting Instrument," issued Aug. 31, 2004, the disclosure of which is incorporated by reference herein; U.S. Pat. No. 6,364,888, entitled "Alignment of Master and Slave in a Minimally Invasive Surgical Apparatus," issued Apr. 2, 2002, the disclosure of which is incorporated by reference herein; U.S. Pat. No. 7,524,320, entitled "Mechanical Actuator Interface System for Robotic Surgical Tools," issued Apr. 28, 2009, the disclosure of which is incorporated by reference herein; U.S. Pat. No. 7,691,098, entitled "Platform Link Wrist Mechanism," issued Apr. 6, 2010, the disclosure of which is incorporated by reference herein; U.S. Pat. No. 7,806,891, entitled "Repositioning and Reorientation of Master/Slave Relationship in Minimally Invasive Telesurgery," issued Oct. 5, 2010, the disclosure of which is incorporated by reference herein; U.S. Pub. No. 2013/0012957, entitled "Automated End Effector Component Reloading System for Use with a Robotic System, published Jan. 10, 2013, issued as U.S. Pat. No. 8,844,789 on Sep. 30, 2014, the disclosure of which is incorporated by reference herein; U.S. Pub. No. 2012/0199630, entitled "Robotically-Controlled Surgical Instrument with Force-Feedback Capabilities," published Aug. 9, 2012, issued as U.S. Pat. No. 8,820,605 on Sep. 2, 2014, the disclosure of which is incorporated by reference herein; U.S. Pub. No. 2012/0132450, entitled "Shiftable Drive Interface for Robotically-Controlled Surgical Tool," published May 31, 2012, issued as U.S. Pat. No. 8,616,431 on Dec. 31, 2013, the disclosure of which is incorporated by reference herein; U.S. Pub. No. 2012/0199633, entitled "Surgical Stapling Instruments with Cam-Driven Staple Deployment Arrangements," published Aug. 9, 2012, issued as U.S. Pat. No. 8,573,461 on Nov. 5, 2013, the disclosure of which is incorporated by reference herein; U.S. Pub. No. 2012/0199631, entitled "Robotically-Controlled Motorized Surgical End Effector System with Rotary Actuated Closure Systems Having Variable Actuation Speeds," published Aug. 9, 2012, issued as U.S. Pat. No. 8,602,288 on Dec. 10, 2013, the disclosure of which is incorporated by reference herein; U.S. Pub. No. 2012/0199632, entitled "Robotically-Controlled Surgical Instrument with Selectively Articulatable End Effector," published Aug. 9, 2012, issued as U.S. Pat. No. 9,301,759 on Apr. 5, 2016, the disclosure of which is incorporated by reference herein; U.S. Pub. No. 2012/0203247, entitled "Robotically-Controlled Surgical End Effector System," published Aug. 9, 2012, issued as U.S. Pat. No. 8,783,541 on Jul. 22, 2014, the disclosure of which is incorporated by reference herein; U.S. Pub. No. 2012/0211546, entitled "Drive Interface for Operably Coupling a Manipulatable Surgical Tool to a Robot," published Aug. 23, 2012, issued as U.S. Pat. No. 8,479,969 on Jul. 9, 2013; U.S. Pub. No. 2012/0138660, entitled "Robotically-Controlled Cable-Based Surgical End Effectors," published Jun. 7, 2012, issued as U.S. Pat. No. 8,800,838 on Aug. 12, 2014, the disclosure of which is incorporated by reference herein; and/or U.S. Pub. No. 2012/0205421, entitled "Robotically-Controlled Surgical End Effector System with Rotary Actuated Closure Systems," published Aug. 16, 2012, issued as U.S. Pat. No. 8,573,465 on Nov. 5, 2013, the disclosure of which is incorporated by reference herein.

Versions of the devices described above may be designed to be disposed of after a single use, or they can be designed to be used multiple times. Versions may, in either or both cases, be reconditioned for reuse after at least one use. Reconditioning may include any combination of the steps of disassembly of the device, followed by cleaning or replacement of particular pieces, and subsequent reassembly. In particular, some versions of the device may be disassembled, and any number of the particular pieces or parts of the device may be selectively replaced or removed in any combination. Upon cleaning and/or replacement of particular parts, some versions of the device may be reassembled for subsequent use either at a reconditioning facility, or by a user immediately prior to a procedure. Those skilled in the art will appreciate that reconditioning of a device may utilize a variety of techniques for disassembly, cleaning/replacement, and reassembly. Use of such techniques, and the resulting reconditioned device, are all within the scope of the present application.

By way of example only, versions described herein may be sterilized before and/or after a procedure. In one sterilization technique, the device is placed in a closed and sealed container, such as a plastic or TYVEK bag. The container and device may then be placed in a field of radiation that can penetrate the container, such as gamma radiation, x-rays, or high-energy electrons. The radiation may kill bacteria on the device and in the container. The sterilized device may then be stored in the sterile container for later use. A device may also be sterilized using any other technique known in the art, including but not limited to beta or gamma radiation, ethylene oxide, or steam.

Having shown and described various embodiments of the present invention, further adaptations of the methods and systems described herein may be accomplished by appropriate modifications by one of ordinary skill in the art without departing from the scope of the present invention. Several of such potential modifications have been mentioned, and others will be apparent to those skilled in the art. For instance, the examples, embodiments, geometries, materials, dimensions, ratios, steps, and the like discussed above are illustrative and are not required. Accordingly, the scope

of the present invention should be considered in terms of the following claims and is understood not to be limited to the details of structure and operation shown and described in the specification and drawings.

We claim:

1. A stretchable buttress assembly for reinforcing the mechanical fastening of tissue by surgical staples that are deployable from a surgical stapler, the buttress assembly comprising:

(a) a planar fabric layer having a first side and a second side opposite the first side, wherein the planar fabric layer is configured to stretch along a stretch axis, wherein the planar fabric layer comprises:

(i) a plurality of extensible fibers arranged in a repeatable pattern, wherein the extensible fibers are oriented along respective paths that are each parallel to the stretch axis, and

(ii) a plurality of non-extensible fibers arranged in a repeatable pattern and engaged with the extensible fibers; and

(b) a biocompatible adhesive layer, wherein the adhesive layer is applied to the first side of the planar fabric and is configured to removably adhere the planar fabric layer to an end effector of a surgical stapler.

2. The stretchable buttress assembly of claim **1**, wherein the plurality of non-extensible fibers are oriented transversely to the stretch axis.

3. The stretchable buttress assembly of claim **1**, wherein the extensible fibers are selected from the group consisting of: monocomponent fibers; multicomponent fibers; bicomponent fibers; biconstituent fibers; and combinations thereof.

4. The stretchable buttress assembly of claim **3**, wherein the extensible fibers comprise polymers selected from the group consisting of: poly(caprolactone)-co-poly(glycolide) (PCL/PGA); poly(caprolactone)-co-poly(lactide) (PCL/PLA); poly(lactide)-co-trimethylene carbonate (PCL/TMC); poly(p-dioxanone) (PDS); polyglactin 910; and combinations thereof.

5. The stretchable buttress assembly of claim **1**, wherein the non-extensible fibers are selected from the group consisting of: monocomponent fibers; multicomponent fibers; bicomponent fibers; biconstituent fibers; and combinations thereof.

6. The stretchable buttress assembly of claim **5**, wherein the non-extensible fibers comprise polymers selected from the group consisting of: poly(caprolactone)-co-poly(glycolide) (PCL/PGA); poly(caprolactone)-co-poly(lactide) (PCL/PLA); poly(lactide)-co-trimethylene carbonate (PCL/TMC); poly(p-dioxanone) (PDS); polyglactin 910; polyglycolide (PGA); polyglycolic acid:trimethylcarbonate (PGA:TMC); and combinations thereof.

7. The stretchable buttress assembly of claim **1**, wherein the non-extensible fibers and extensible fibers are woven together in a pattern selected from the group consisting of: twill weave; plain weave; satin weave; and combinations thereof.

8. The stretchable buttress assembly of claim **1**, wherein the non-extensible fibers and extensible fibers are knitted together in a Raschel weft-insertion pattern.

9. The stretchable buttress assembly of claim **8**, wherein the extensible fibers are bicomponent fibers comprising non-elastic fibers wrapped around elastic fibers.

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